ROYAL BOTANIC GARDENS, KEW.

BULLETIN

OF

MISCELLANEOUS INFORMATION.

No. 2] [1921

III.—NEW OR NOTEWORTHY SOUTH AFRICAN PLANTS (I.).

JOSEPH BURTT-DAVY.

1. **Indigofera Buchananii,** *Burtt-Davy* [Leguminosae-Galegeae]; species *I. Guthriei,* Bolus, *I. gramineae,* Schltr., et *I. simplicifoliae,* Lam., affinis, sed fruticulus humilis, erectus vel decumbens, multiramosus, stipulis setaceis 3–6 mm. longis glandulosis, foliis brevissime petiolatis linearibus angustatis longe acuminatis vel mucronatis facile distinctus.

Herba perennis (?). *Caulis* erectus, aliquanto tenuis, 2·5–3·5 dm. (vel ultra?) altus, valde ramosus, castaneo-brunneus. *Rami* tenues, ex axillis omnium foliorum crescentes. *Stipulae* setaceae, 3–6 mm. longae, glandulosae. *Petioli* circiter 1 mm. longi. *Foliola* linearia, longe acuminata vel mucronata, 5–5·5 cm. longa, 3 mm. lata, plicata, marginibus glandulosis. *Flores* axillares; pedunculi filiformes, circiter 1 cm. longi, 1–4-flori. *Calycis* dentes anguste lanceolati vel subulati. *Corolla* circiter 6 mm. longa. *Legumen* valde tenue, circiter 2·5 cm. longum.

SOUTH AFRICA. Transvaal: Ermelo Dist.; Lion's Glen near Amsterdam, *J. B. Buchanan, T. D. A. Herb.* 4779 *in herb. Bolus.*

Native name: "M'Lumo"; supposed to be poisonous to live stock.

2. **Rhynchosia unifoliolata,** *Burtt-Davy* [Leguminosae-Phaseoleae]; species *R. Tottae,* Harv. (Fl. Cap. ii. 255), affinis, sed foliis saepe unifoliolatis et foliolorum forma differt.

Caules valde graciles, prostrati, ad basim ramosi. *Foliola* singula vel terna; foliolum terminale ovatum et acutum, 1·2–1·8 cm. longum, 8–9 mm. latum, reticulatum; petiolus 1–2 mm. longus; stipulae lanceolatae, 2·5–3 mm. longae. *Pedunculi* graciles, axillares, solitarii vel geminati, 2·5–4 cm. longi, floribus 1 vel 2; bracteae minutae. *Flores* 7–8 mm. longi; pedicelli valde breves. *Calyx* pubescens, lobis acuminatis.

SOUTH AFRICA. Transvaal: Ermelo Dist.; Ermelo, about 1620 m., *Burtt-Davy* 17403, *in herb. Bolus et Kew.* Standerton Dist.; Hoogeveld near Paardekopberg, *Rehmann* 6836.

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3. **Tephrosia Burchellii,** *Burtt-Davy* [Leguminosae-Galegeae]; species *T. capensi*, Pers. et *T. semiglabrae*, Sond. affinis, sed foliolis obovatis retusis mucronulatis distinguitur.

Herba tenuis, prostrata, pilis porrectis sparse hirsuta. *Caules* annui e collo perenni crescentes, 23–30 cm. longi, flexuosi, a basi ramosi, internodiis 4–5 cm. longis. *Folia* breviter petiolata, 5–7-juga, 4·5–5 cm. longa; rhachis pilis porrectis hirsuta; foliola 4–9 mm. distantia, obovata, retusa, mucronulata, 1–1·2 cm. longa, 5–7 mm. lata, glauca, ciliata, supra glabra, pagina inferiore sparse hirsuta praecipue in costa. *Stipulae* circiter 3 mm. longae. *Racemi* axillares, foliis longiores, floribus paucis (circiter 6); pedunculi longi et tenues. *Flores* circiter 6 mm. longi, 2 vel 3-tim aggregati, infimis fasciculis remotis. *Calyx* pilis longis et porrectis albescentibus hirsutus, lobis subulatis circiter 3 mm. longis. *Corollae* vexillum in dorso pubescens. *Legumen* 3–4 cm. longum, 3 mm. latum, falcatum, pilis appressis puberulum, stylo persistente rostratum.

South Africa. Cape Province: Griqualand W.; Hay Div., Griquatown, *Burchell* 1932 (type); "fields" near St. Clair, Douglas, Dec. 1896, *K. Orpen* 132A *in herb. Kew* Bechuanaland; Batlapin Terr., *Holub.* Orange Free State: Boshof Dist.; Smitskraal, *Burtt-Davy* 12905. Transvaal: Wolmaransstad, *Rogers* 18470; Bloemhof Dist., near Christiana, *Burtt-Davy.*

A common and characteristic plant of the Southern Bechuanaland Region, which has for some time been confused with *T. capensis.*

4. **Peltophorum africanum,** *Sond.*, var. **speciosum** *Burtt-Davy* [Leguminosae-Caesalpinioideae]; formae typicae affinis, sed floribus foliolisque majoribus differt.

Foliola circiter 17-juga, 1·3 cm. longa, 4–5 mm. lata, obtusa, mucronata vel emarginata, glabra vel sparse hirsuta, costa subtus prominente. *Flores* magni, flavi, speciosi. *Petala* 1·4 cm. longa, 1·2 cm. lata. *Legumen* ad 8 cm. longum et 3 cm. latum.

Tropical Africa. S. Rhodesia: Matopo Hills, *Dowsett in herb. Bolus*, 16426 (type). Mauritius: *Dep. Agric. herb.* 66 *in herb. Kew.*

A form intermediate between this and the typical South African tree occurs in Portuguese East Africa (Muchukwana, Lower Buzi River, 100 ft. alt., *Swynnerton* 1022).

5. **Acacia Nebrownii,** *Burtt-Davy* [Leguminosae-Mimosoideae]; *A. glandulifera*, Schinz in Mém. Herb. Boiss. No. 1, p. 111, non *A. glandulifera*, S. Wats. in Proc. Am. Acad. xxv. 147 (1890).

South Africa. Transvaal: Waterberg Dist., Potgietersrust, *Burtt-Davy;* Pietersburg Dist., Leydsdorp and Smits Drift Valley, *Burtt-Davy;* Swaziland, near Bremersdorp, *Burtt-Davy.* Ngamiland: Kwebe Hills, 900 m., bush 5–6 ft., fls. yellow, Feb.-Aug., frt. Sep. *Mrs. E. J. Lugard* (type). S.W. Protectorate: bush 8–15 ft. high, common on flats, plateaus, river banks and

dry river beds; Gurmaris, *Pearson* 9256; Holoog, *Pearson* 9814. Namseb, *Pearson* 9335. Bull's Mouth Pass, *Pearson* 8945.

6. **Vahlia capensis,** *Thunb.*, var. **latifolia,** *Burtt-Davy* [Saxifragaceae-Saxifrageae]; a forma typica foliis multo latioribus et pedunculis longioribus differt.

Herba perennis, viscido-puberula. *Folia* oblanceolata, acuta, 1·8–2·5 cm. longa, 3 mm. lata. *Pedunculi* 3–6 mm. longi ex plurimorum foliorum superiorum axillis orti, floribus 1 vel 2, pedicellis brevibus. *Petala* lata, conspicua, 4 mm. longa, flava.

South Africa. Transvaal: Vereeniging Dist.; Uitgevallen 197, about 1480 m., on red quartzite soil, *Burtt-Davy* 15082 *in herb. Bolus.*

7. **Salacia** (?) **transvaalensis,** *Burtt-Davy* [Hippocrateaceae]; frutex habitu folioque *Pterocelastri echinati,* N.E.Br., sed staminibus 3.

Frutex ramosus, glaber, ramulis brevibus rigidis. *Foliorum* petioli 3–4 mm. longi; laminae oblanceolatae vel obovatae, obtusatae vel acutiusculae, 2·4–2·7 cm. longae, 0·8–1·2 cm. latae. *Pedunculi* 1 cm. longi, in axillis foliorum superioribus, multiflori; pedicelli ad 4 mm. longi. *Petala* corollae circiter 3 mm. longa. *Stamina* 3.

South Africa. Transvaal: Lydenburg Dist.; Sabie-hoek forest, January 1906, *Burtt-Davy* 1699.

The habit is unlike that of any other *Salacia* known to me, fruit is needed in order to determine its precise affinity.

8. **Lannea Kirkii,** *Burtt-Davy* [Anacardiaceae-Anacardieae]; *L. Stuhlmanni,* Engl., affinis, foliolis longioribus angustioribusque, pedunculis et pedicellis stellato-pubescentibus, sepalis ciliatis differt.

Arbor parva. *Folia* plerumque 2-juga, 12·5–23 cm. longa, petiolis et foliolis subtus (praecipue in costis et axillis nervorum) sparse stellato-tomentosis supra glabris; petioli 5–6·5 cm. longi; foliola ovata vel oblonga, obtuse acuminata, 5–9 cm. longa, 3–4·3 cm. lata; petiolulus folioli terminalis 1·3–2·6 cm. longus; foliola lateralia subsessilia, 2·6–4·7 cm. distantia. *Racemi* vel *paniculae* ex axillis foliorum orti; pedunculi 6·3–7·6 cm. longi; pedicelli 3 mm. longi. *Fructus* (immaturi) 0·9–1·2 cm. longi, 6 mm. lati.

South Africa. Transvaal: Zoutpansberg District; Tsama River, a tributary of the Klein Letaba, just north of the Tropic, in young fruit, March 31, 1908, *S. Matthewman in T. D. A. Herb.* 4321 and *Herb. Bolus.* (type). S. Rhodesia: Sabi River, at about 300 m., *Swynnerton* 1205 (Chinado name " Mugan 'enkomo " = Cow " muganu "). Port. E. Africa: Gazaland; Lower Buzi River, 120 m., *Swynnerton* 1035; Zambesia: Shupanga, Lower Zambesi, Jan. 10, 1863, *Dr. Kirk in herb. Kew.*

9. **Rhus Gueinzii,** *Sond.*, var. **brevifoliolata,** *Burtt-Davy* [Anacardiaceae-Anacardieae]; formae typicae affinis sed foliolis

minoribus inaequaliter serratis, terminali circiter 3·8 cm. longo et 0·8–1 cm. lato, differt.

South Africa. Transvaal: Waterberg Dist.; farm Rondebosch near Potgietersrust, *Burtt-Davy* 2175 *in herb. Bolus.*

10. **Ficus Bizanae,** *Hutchinson* et *Burtt-Davy* [Moraceae-Artocarpeae]; affinis *F. politae*, Vahl, sed foliis sensim et breviter acuminatis basi cuneatis vel subrotundatis, pedunculis robustis, receptaculis oblongo-ellipsoideis, ostiolo conspicue mamillato differt.

Arbor magna; ramuli hornotini laxe foliati, sicco brunneo-purpurascentes, glabri. *Folia* elliptica vel oblongo-elliptica, basi cuneata vel subrotundata, apice breviter et obtuse acuminata, 8–15 cm. longa, 3·5–7·5 cm. lata, integra, chartacea, glabra, infra laxe reticulata, basi trinervia; costa supra leviter impressa, infra prominens, basi circiter 2 mm. lata; nervi laterales utrinsecus 5–7, a costa sub angulo 45° abeuntes, intra marginem conjuncti, infra prominentes; petioli graciles, 2·5–6 cm. longi, glabri; stipulae mox caducae, acute triangulares, 4·5 mm. longae, glabrae, nitidae. *Receptacula* fasciculata, in ramulos abbreviatos brevissimos ex trunco et ramis principibus ortos disposita, pedunculata, oblongo-ellipsoidea, basi breviter et abrupte stipitata, apice late et prominenter umbonata, circiter 3·5 cm. longa et 2·5 cm. diametro, maculis magnis notata, minute rufescenti-puberula; pedunculi demum recurvati, 1·5 cm. longi, puberuli. *Bracteae* basales 2, late ovatae, coriaceae, persistentes. *Ostiolum* conspicue elevatum, bilabiatum; bracteolae omnes in receptacula descendentes. *Achenia* ellipsoideo-globosa, nitida.

South Africa. Pondoland: Bizana district; rocky banks of the Umtamvoona River, overhanging the water, *J. Burtt-Davy* 15291.

This is a very distinct fig allied to *F. polita*, Vahl, a species widely spread in Tropical Africa. It belongs to the section *Fasciculatae*, characterised by the figs being borne on short arrested branchlets arising from the trunk or main branches remote from the leaves. When the genus *Ficus* was worked out for the Flora Capensis only two species of this section, *F. sansibarica* and *F. polita*, were known from South Africa, the one now described being a third of this otherwise almost exclusively Tropical Africa group.

IV.—NEW ORCHIDS: DECADES XLVIII.–XLIX.

The novelties described in Decades 48–49 were (with a single exception) collected by Sir Everard F. im Thurn, K.C.M.G., when Governor of Fiji and High Commissioner of the Western Pacific. The majority are natives of the Fiji group, and chiefly of the Island of Viti Levu, but the collection contains plants obtained in the New Hebrides and Solomon Islands.

471. **Microstylis Imthurnii,** *Rolfe;* inter species Vitienses pedicellis longis et gracilibus distincta.

Caulis erectus, brevis, 4–5-foliatus. *Folia* breviter petiolata, late elliptico-lanceolata, breviter acuminata 5-nervia, 7–12 cm. longa, 2·5–4 cm. lata. *Scapus* erectus, circiter 20 cm. longus, multiflorus. *Bracteae* reflexae, oblongo-lineares, acuminatae, 4–5 mm. longae. *Pedicelli* 0·8–1 cm. longi. *Sepalum* posticum ovato-oblongum, obtusum, concavum, 5 mm. longum; sepala lateralia late obovato-oblonga, obtusa, subconcava, 3 mm. longa. *Petala* falcato-linearia, obtusa, 5 mm. longa. *Labellum* circuitu reniformi-orbiculatum, 4·5–5·5 mm. diametro; lobus intermedius late obovatus, truncatus et minute bicuspidatus, lobi laterales ample auriculati et obtusi; discus 5-nervius. *Columna* lata, dentibus minutis.

Fiji. Navai: foot of Mt. Victoria, 850 m., March 28, 1906, *im Thurn* 208.

Flowers vanilla-scented.

472. **Microstylis radicicola,** *Rolfe;* habitu *M. platychilae,* Reichb. f., similis, sed labello ample trilobo differt.

Pseudobulbi ovoideo-oblongi, 3–5 cm. longi, vaginis membranaceis obtecti, 3-folii. *Folia* ovata vel elliptico-ovata, acuta v. breviter acuminata, 7-nervia, 9–14 cm. longa, 3·5–5 cm. lata. *Scapi* erecti, 15–25 cm. longi; racemi 5–8 cm. longi, multiflori. *Bracteae* reflexae, lineares, acuminatae, circiter 5 mm. longae. *Pedicelli* circiter 4 mm. longi. *Sepalum* posticum elliptico-oblongum, obtusum, 6 mm. longum; sepala lateralia falcato-obovata, obtusa, 4 mm. longa. *Petala* oblongo-linearia, obtusa, 3 mm. longa. *Labellum* late reniforme, trilobum, 1·3 cm. latum; lobus intermedius late obovatus, truncatus, denticulatus, 0·8–0·9 cm. latus; lobi laterales obovati, 0·5 cm. longi. *Columna* lata.

Fiji. Nandarivatu, on mossy tree roots above ground in shady forest, Feb. 1, 1906, *im Thurn* 64.

This somewhat resembles *M. platychila,* Reichb. f., in habit, but the stems are shorter and more swollen at the base, and the flowers do not agree in structure.

473. **Microstylis latisepala,** *Rolfe;* a *M. Schlechteri,* Rolfe (*M. vitiensis,* Schlechter, non Rolfe) foliis multo majoribus et labello obscure trilobo differt.

Caulis subelongatus, 7–9-foliatus. *Folia* petiolata, elliptico-lanceolata, breviter acuminata, 5-nervosa, 10–15 cm. longa, 3–5 cm. lata; petiolus 4–7 cm. longus, basi ample vaginatus. *Scapus* subelongatus, 10–15 cm. longus, multiflorus. *Bracteae* reflexae, lineares, acuminatae, 0·8–1·2 cm. longae. *Pedicelli* 4–5 mm. longi. *Sepala* elliptico-ovata, 4 mm. longa, apice reflexa et obtusa. *Petala* oblonga, obtusa, 3 mm. longa. *Labellum* circuitu orbiculare, 4–5 mm. diametro, basi late et obtuse auriculata, apice obscure trilobo. *Columna* lata, dentibus oblongis.

Fiji. Navai, March 28, 1906, *im Thurn* 209.

A much larger plant than *M. Schlechteri*, Rolfe (*M. vitiensis*, Schlechter, nec Rolfe), but, judging from the description, approaching it in floral structure. The leaf of *M. latisepala* is said to be purplish, and the flower purple.

474. **Microstylis Everardii,** *Rolfe;* inter species Vitienses labello ample sagittato-auriculato distinctis.

Caulis brevis, 4–5-foliatus. *Folia* breviter petiolata, elliptico-ovata, breviter acuminata, 3–6 cm. longa, 1·8–3 cm. lata, 5-nervia; petioli basi laxe vaginati. *Scapi* circiter 7 cm. longi, pauciflori. *Bracteae* patentes vel reflexae, lineares, 2–3 mm. longae. *Pedicelli* circiter 5 mm. longi. *Sepalum* posticum elliptico-oblongum, obtusum, 6 mm. longum; sepala lateralia falcato-ovata, subobtusa, 2·5 cm. longa. *Petala* lineari-oblonga, obtusa, 4 mm. lata. *Labellum* circuitu elliptico-orbiculare, 3·5 mm. diametro; lobus intermedius late oblongus, bidentatus, lobi laterales ample sagittato-auriculati, oblongi, obtusi. *Columna* lata, dentibus minutis.

Fiji. Navai, March, 1906, *im Thurn*, s.n.

A rather small, lax-flowered species.

475. **Microstylis longifolia,** *Rolfe;* inter species Vitienses foliis angustis et attenuatis facile distinguenda.

Caules subelongati, 5–6-folii. *Folia* lineari-lanceolata, acuminata, 6–12 cm. longa, 0·5–0·8 cm. lata, basi vaginis ovato-lanceolatis dilatata. *Scapi* 10–15 cm. longi, laxiflori. *Bracteae* patentes vel subreflexae, lanceolatae, acuminatae, 4–6 mm. longae. *Pedicelli* 5–6 mm. longi. *Sepala* ovata, subobtusa, concava, 3 mm. longa. *Petala* lineari-lanceolata, subacuta, 4–5 mm. longa. *Labellum* circuitu orbiculare, trilobum, circiter 4 mm. latum; lobi laterales late auriculati, lobus intermedius suborbicularis, profunde fimbriatus. *Columna* lata, brevis, dentata.

Fiji. Common everywhere in Fiji in the forks of the Ivi (Inocarpus, &c.) trees, Jan. 1878, *J. Horne.*

A fruiting specimen collected by Seemann (n. 616) at Motariki is quite similar in habit, but has longer scapes and leaves and may be different. Reichenbach labelled it "*Liparis* non-determinable," but it has the short broad column of *Microstylis.*

476. **Liparis (§ Coriifolii) vitiensis,** *Rolfe;* a *L. longipede*, Lindl., racemis multo laxioribus differt.

Pseudobulbi oblongi, 2–3 cm. longi, diphylli, basi vaginis ovato-lanceolatis obtecti. *Folia* lanceolata, acuta, 5-nervia, subcoriacea, 8–16 cm. longa, 1–1·5 cm. lata. *Scapi* erecti, 14–20 cm. longi, laxe multiflori. *Bracteae* lanceolato-lineares, acutae, 4–6 mm. longae. *Pedicelli* 0·7–1·0 cm. longi. *Sepala* recurva, oblongo-linearia, obtusa, subacuta, circiter 3·5 mm. longa. *Petala* recurva, linearia, acuta, 3·5 cm. longa. *Labellum* recurvum, obovato-oblongum, obtusum, circiter 3·5 cm. longum; discus ecallosus. *Columna* clavata, curvata, 2 mm. longa.

Fiji. Vesari Swamp, in forest by side of Suva Navua road, July 28, 1907, *im Thurn* 370.

477. **Dendrobium (Grastidium) Everardii,** *Rolfe;* affine *D. dactylodi,* Reichb. f., sed floribus duplo brevioribus facile distinguendum.

Caules erecti, subgraciles, 20–30 cm. longi, distichophylli. *Folia* oblongo-lanceolata, obtusa, coriacea, 3·5–7 cm. longa, 0·8–1·5 cm. lata, vaginis striatis. *Inflorescentia* axillaris, brevissima, biflora vel uniflora, basi vaginis late oblongis obtusis, striatulis 0·5 cm. longis obtecta. *Bracteae* minutae. *Pedicelli* 1 cm. longi. *Sepalum* posticum incurvum, lineari-lanceolatum, acutum, 1·5 cm. longum; sepala lateralia triangulari-oblonga, acuta, 1·3–1·5 cm. longa. *Petala* incurva, linearia, acuta, 1·5 cm. longa. *Labellum* unguiculatum, trilobum, 6–7 mm. longum; lobi laterales lati, subacuti, lobus intermedius spiraliter recurvus, acutus, margine undulato-crispus. *Columna* lata, 4 mm. longa.

Fiji. Nandrau, Dec. 5, 1906, *im Thurn* 316. Nandarivatu, Dec. 7, 1906, *im Thurn* 326.

Closely resembling the Samoan *D. dactylodes,* Reichb. f., in general appearance, but differing markedly in the broad and far shorter floral segments. Flowers yellow.

478. **Dendrobium (Grastidium) malaitense,** *Rolfe; D. salactensi,* Lindl., affine, sed floribus multo majoribus differt.

Caules subgraciles, elongati, 3–4 mm. lati, distichophylli. *Folia* subpatentia, elongato-ligulata, inaequaliter bidentata et obtusa, 9–17 cm. longa, 0·8–1·1 cm. lata, vaginis minute striatulis et rugulosis. *Racemi* biflori, basi spathis semiorbicularibus brevibus obtecti. *Pedicelli* 0·7–0·8 cm. longi. *Sepalum* posticum elliptico-oblongum, subobtusum, circiter 1·5 cm. longum, 0·5–0·6 cm. latum; sepala lateralia oblonga, subobtusa, 1·5 cm. longa, 0·6 cm. lata, basi in mentum breve obtusum extensa. *Petala* elliptica, subobtusa, 1·5 cm. longa, 0·7 cm. lata. *Labellum* pandurato-trilobum, 1 cm. longum; lobi laterales suborbiculares, 3 mm. longi, lobus intermedius ovato-oblongus, subacutus, 3·5–4 mm. latus; discus minute carinatus. *Columna* lata, 3·5 mm. longa.

Solomon Islands. Langi Langi, Malaita, Aug. 1905, *im Thurn,* 363. Flowered at Suva, Aug. 1907. Flowers white, ephemeral and very easily detached.

Near *D. salaccense,* Blume, and *D. alagense,* Ames, but with larger flowers.

479. **Dendrobium (Rhizobium) calamiforme,** *Rolfe;* a *D. crispato,* Swartz, foliis longioribus et floribus multo majoribus differt.

Caulis ramosus, patenti-pendulus, gracilis, apice monophyllus. *Folia* teretia, acuta, 7–20 cm. longa, 3–5 mm. lata. *Racemi* graciles, 7–15 cm. longi, laxiflori. *Bracteae* subobsoletae.

Pedicelli 1·5 cm. longi. *Sepalum* posticum lineare, acutum, 1·5 cm. longum; sepala lateralia posticum similia, basi in mentum oblongum obtusum 0·8–1 cm. longum extensa. *Petala* anguste linearia, acuta, 1·5 cm. longa. *Labellum* trilobum, 1·5 cm. longum; lobi laterales oblongi, obtusi, 0·8 cm. longi, lobus intermedius recurvus, lineari-lanceolatus, acuminatus, crispo-undulatus, 0·7 cm. longus. *Columna* lata, 2 mm. longa. *D. crispatum*, Seem. Syn. Pl. Vit., p. 12; Reichb. f., in Seem. Fl. Vit., p. 303 (non Swartz); Kraenzl. in Engl. Pflanzenr. Orch. Dendrob. i., p. 293, ex parte).

Fiji. *Seemann*, 579; *Horne*, 1085. Nandarivatu, *im Thurn* 376.

New Hebrides, Rason's Island, Vila Harbour, Dec. 26, 1906, *im Thurn* 328.

Allied to the Tahitian *D. crispatum*, Swartz, with which it has been confused, but readily distinguished by its much longer leaves and the flowers double the size. Horne remarks: "Common at some places on trees overhanging the sea and salt water marshes. Flowers, yellow." Seemann originally identified the plant with the Australian *D. calamiforme*, Lodd., but as the latter is synonymous with *D. teretifolium*, R. Br., it leaves the very characteristic specific name free for the present plant. The later identification with the Tahitian *D. crispatum*, Swartz, is also erroneous.

480. **Dendrobium** (§ **Speciosa**) **vitiense,** *Rolfe; D. agrostophyllo*, F. Muell., simile, sed floribus multo minoribus differt. *Caules* subgraciles, erecti, subcylindrici, 12–14 cm. longi, supra nodos leviter constricti, distichophylli. *Folia* oblongo-lanceolata, breviter et inaequaliter biloba, subcoriacea, 4–5 cm. longa, 0·6–1 cm. lata. *Racemi* axillares, subgraciles, 2·5–4 cm. longi, laxiflori. *Bracteae* late ovatae, subobtusae, 1 mm. longae. *Pedicelli* 0·5–0·8 cm. longi. *Sepalum* posticum ovatum, obtusum, 4 mm. longum; sepala lateralia late ovata, obtusa, 5 mm. longa, basi in saccum breven obtusum extensa. *Petala* elliptica, obtusa, 4 mm. longa. *Labellum* latum, trilobum, 4 mm. longum; lobi laterales breves, obtusi, lobus intermedius reniformis, subemarginatus, 2·5–3 mm. latus; discus obtuse bicarinatus. *Columna* lata, 1 mm. longa.

Fiji. Nandrau, in mountains of Viti Levu, 1500 m., Dec. 5, 1906, *im Thurn* 317.

This species has much the general habit of *D. agrostophyllum*, F. Muell., to which it is apparently allied, but has far smaller flowers. The latter are described as purple.

—NOTES ON SPECIES OF COLLETOTRICHUM AND PHOMA IN UGANDA.

W. Small.

A.—Colletotrichum on Coffee and Cacao.

Colletotrichum coffeanum, *Noack*, and Phoma sp. **on coffee.**—A species of *Colletotrichum* of economic importance was first recorded in Uganda about the year 1908 when Dawe sent to Kew coffee* material showing leaf-blotching and gradual withering of the branches. Massee had proposed the name of *Colletotrichum coffeae* for a fungus found on the affected leaves and twigs, but his description was never published. *C. coffeae* is therefore a *nomen nudum*, and it is more than likely that Massee's *C. coffeae* was *Colletotrichum coffeanum*, Noack, which was named and described in 1901 from material from Brazil.† *Colletotrichum coffeanum* occurs so regularly on Uganda coffee in association with what has been termed "dieback," that we are justified in concluding that it was present in the country in 1908, even although the details of the 1908 disease are so meagre that there can be no certainty that its effects, particularly the withering of branches ascribed to it, were similar to present-day dieback. This fungus has a wide distribution. It has been reported from South India, Brazil, Costa Rica and Porto Rico, while *Gloeosporium coffeanum*, Del., which is probably the same fungus, despite the lack of the setae usually found on acervuli of *Colletotrichum*, has been found in Réunion, Madagascar and Java. Another species of the same genus, *C. incarnatum*, Zimm., which may be, and probably is, identical with *C. coffeanum*, has been known for several years on coffee leaves in what was German East Africa.‡ *C. incarnatum* has also been given as the cause of a dieback of *Coffea robusta* in Ceylon,§ but, so far as the writer is aware, no experiments have been undertaken to test the assertion.

In 1913, a species of *Colletotrichum*, subsequently identified as *C. coffeanum*, Noack, was found by the writer on coffee branches‖ which were dying back, but its presence was not of regular occurrence. In later years, however, leaf-blotching became more prominent at intervals, and *Colletotrichum* was found to be associated more regularly with that affection and with dieback twigs. It was also found to attack the berries, and there seems no room to doubt that it was becoming increasingly plentiful in its occurrence on the various parts of the coffee tree. Quite naturally there was then a tendency to ascribe all coffee dieback to the work of *Colletotrichum*. But, as was pointed

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* *Coffea arabica.*

† Zeitschr. f. Pflanzenkr. II, 1901, p. 196.

‡ Der Pflanzer, 1913, 9, 76.

§ Tropical Agriculturist, 45, 156, Sept., 1915.

‖ Annual Report, Dept. Agric. Uganda, 1913–14, p. 60.

out in 1915,* other fungi were found on dieback branches, viz., *Periconia byssoides*, Pers., *Phoma* sp., *Fusarium coffeicola*, P. Henn., a second species of *Fusarium*, and *Tubercularia* sp. It was also emphasised that various physiological factors were involved in the production of dieback. The *Phoma* and *Tubercularia* were at that time scarcer than the other fungi, and none of the forms was constant in its presence on dieback branches. Moreover, the mode of parasitism seemed unusual. The *Periconia* and *Tubercularia* were always regarded as saprophytes, and recent work† has shown that both the species of *Fusarium* should be placed in the same category. Other forms found at times on dieback coffee branches are the perithecia of *Capnodium brasiliensis*, Putt., the fungus of sooty mould, and of a species of *Glomerella*, the complete stage of *Colletotrichum coffeanum*, which is found after the lapse of three or more months on twigs kept in the damp, an ascomycete which may be the ascigerous stage of the *Phoma*, and a *Coniothecium* which forms a stage in the life-history of the *Phoma*. The supposed ascigerous stage of the *Phoma* is very rare. At the present day, the preponderance of numbers is at times in favour of *Colletotrichum*, at others in favour of *Phoma*.

Histological examination of certain dieback coffee branches discloses the presence of mycelium in the tissues of wood and cortex. This mycelium is septate, branched, and pale brown or hyaline in colour, and it may be nodulose. It penetrates transverse cell-walls, disorganises longitudinal cell-walls, and so works its way between adjacent cells as to bring about splitting and cracking. It impregnates the cortical tissues more fully than those of the wood, and it consumes the cell-contents, for none are visible where invading hyphae are present. This mycelium can be shown to belong to *Phoma* or *Colletotrichum;* the nodulose mycelium would appear to be that of *Phoma*.

In the elucidation of the parts played by the different fungi associated with coffee dieback in Uganda, it was found necessary to grow in pure culture *Colletotrichum*, *Phoma*, *Fusarium coffeicola* and *Fusarium* sp., these fungi being more consistent in their presence on dieback branches and seeming to be more implicated in the production of dieback than any of the other forms mentioned. Two and a half per cent. agar tubes and plates were used, and a nutrient base was supplied by sugar-cane, prune, coffee-leaf, or cacao-pod extract or decoction. The fungi were also grown on sterilised coffee-wood blocks and coffee leaves. Inoculations of the various media were made by the direct transfer of spores on the point of a sterile needle, or by suspending the spores in a drop of sterile distilled water and using a platinum loop.

Colletotrichum coffeanum in pure culture.—Conidia of *Colletotrichum* germinate readily at laboratory temperature in a few

* Annual Report, Dept. Agric. Uganda, 1914–15, p. 61.

† Small: Dieback of *Coffea arabica* in Uganda: Circ. No. 4, Dept. Agric. 1920.

hours in hanging-drops of sugar-cane extract, prune decoction, or distilled water. During germination they become septate, and extrude hyaline, septate, finely-granular germ-tubes of a thickness of 3 μ. The germ-tubes may branch quite early. After twenty-four hours, numerous dark-brown appressoria are formed; in a further eighteen hours, the hanging-drop appears to the eye as a mass of white hyphae. In solid media, the fungus grows rapidly. Aerial white flocculent mycelium appears overnight, and conidial formation takes place in three or four days. On sterilised blocks of coffee-wood in Roux tubes results are similar, and subsequent examination shows the hyphae of the fungus to have penetrated the blocks. Setal formation takes place comparatively seldom. It may depend on the amount of moisture present or on the age of the acervulus, but modifications in the moisture content of the Roux tubes did not seem to influence the appearance or non-appearance of the setae. On the acervuli of *Colletotrichum* on twigs in a damp chamber, setae frequently do not develop at all, or they may appear late when conidial production is slackening down. They may be, for example, only half the length given by Zimmerman for the setae of *Colletotrichum incarnatum** five days after the conidia are ready to, and do, germinate. On sterilised coffee leaves, the fungus produces no setae. This is the case also in nature when the fungus attacks the leaves. On the berries, again, setae may or may not occur. The presence or absence of setae is thus an inconstant character, and, though it has been usual to refer setae-less acervuli to the genus *Gloeosporium*, the writer's opinion is that the acervuli and conidia of *Gloeosporium* on the leaves (*G. coffeanum*, Del.), and the *Colletotrichum* on the stems are indistinguishable and that the two species may well be the same. Cultures were prepared from stem, leaf, and berry material, *i.e.*, from both *Colletotrichum* and *Gloeosporium* spores, and no differences could be detected in the growth of the various mycelia or in conidial formation. It is generally agreed that the separating line between *Colletotrichum* and *Gloeosporium* is a narrow one, and that the basis of distinction is artificial, and it would appear that the presence or absence of setae is governed more by physiological conditions than by a hard-and-fast morphological rule.

Inoculations with Colletotrichum coffeanum.—Material consisting of conidia and mycelium from the cultures was used in inoculation experiments in the study of coffee dieback. Inoculations were made (1) by wounds and punctures on twigs at the nodes, in the course of the internodes, and at the tender growing point of the stem, and (2) by placing the inoculum on both surfaces of leaves, on the unwounded bark of nodes and internodes of twigs, and upon the apical growing point. Young healthy plants were used for the most part, but fresh healthy twigs were also employed. The latter were kept in cylinders of

* Noack gave no measurements of the setae of *C. coffeanum*.

Sach's water-culture solution alternated at intervals of seven or ten days with rain water. Controls were kept in all experiments, and the viability of the inoculum conidia was tested in hanging-drops. It was found that the leaf-inoculations were far more successful than any of the others. In fact, eleven out of twelve leaf-inoculations gave positive results, while only one out of thirty-two of the others was successful. At a later date, two further series of leaf-inoculations gave 100 per cent. positive results. Older tougher leaves were as susceptible as younger leaves, and the upper surfaces as the under. The first signs of leaf-infection were noticeable after fifteen or sixteen days, and the mycelium of the fungus was traceable through the leaf-petioles into the stems. Later, numerous acervuli developed on the twigs bearing the inoculated leaves and on the leaves themselves after about ten days in a damp chamber. The one successful stem inoculation was made through a punctured wound in the growing point. Twelve days after inoculation, the stem apex began to blacken. This was followed by the collapse of the apical pair of leaves and by the extension downwards of the discoloration. *Colletotrichum* was afterwards recovered from the affected stem.

A full discussion of the significance of *Colletotrichum* in connection with coffee dieback need not be initiated here, for details are to be found in the publication referred to.* Suffice it to say that the infective conidia of *Colletotrichum coffeanum* have been shown to be common in the atmosphere and that they have been proved capable of invading the coffee tree, and to note that the conclusion has been arrived at that *Colletotrichum coffeanum* is not an aggressive parasite of the coffee tree, and that it need not bring on attacks of dieback unless the conditions for its advance are rendered favourable. That this is so has been proved in practice. Unfortunately a survey of the history of coffee in Uganda shows that the crop was often not as able as it might have been to resist attacks of *Colletotrichum*. The older trees were seriously weakened by leaf disease (*Hemileia vastatrix*, B. and Br.) at a time when they were in full bearing of what was, in many cases, their first full crop, by the effects of overbearing, by neglect of cultivation and pruning, by the lack of attention to seed-selection and the necessity for rearing and planting out only the best plants, by hurried planting, and by successive serious attacks of various insect pests. At the present time, the oldest coffee in many cases seems to be still suffering from the leaf-disease and overbearing of 1913–14 and to be subject to dieback, despite the increased attention that has been given to it, while younger coffee which has been brought up, as it were, in the light of the experience gained from a study of the behaviour of the older trees, is found to suffer from true dieback to the extent of only a branch here and there. The older larger-scale

* Small: Dieback of *Coffea arabica* in Uganda. Circ. No. 4, Dept. of Agric. 1920.

dieback took the form of the complete desiccation of all the main branches situated between the oldest basal mass of branches and the apical crown of young non-bearing shoots of what was as yet an un-" topped " tree. After " topping " and the resulting cessation of upward growth, the desiccated branches were to be found also at the top of the tree, for the apical branches had by then come into bearing. It might be remarked at this point, in leaving this part of the subject, that *desiccation of coffee branches* or even *coffee-tree desiccation* would be a more correct and more scientific name for the condition known as *dieback*, and that, when only one or a few branches are affected, the term *anthracnose* might be used. Local use and custom are such, however, that it is desirable to retain the name of *dieback*, and to distinguish in practice between large-scale and small-scale varieties of it.

Colletotrichum and Glomerella: cross-inoculations.—After from fifteen to twenty days, certain of the pure cultures of *Colletotrichum coffeanum* will show caespitose perithecia of a species of *Glomerella*. These succeed the acervulus stage. This *Glomerella* has been identified at Kew as *C. cingulata*, S. and v. S., and it has been obtained in other ways. As already mentioned, it may succeed the acervuli of *Colletotrichum coffeanum* on coffee twigs after the lapse of a few months.

In the course of investigation, it was found that there were practically no morphological differences between *C. coffeanum* on coffee and the *Colletotrichum* occurring on rotted and hardened cacao pods. The latter from hardened pod-shells was identified at Kew as *Colletotrichum theobromicolum*, Del., but what appeared to be exactly the same form on rotted parts of pods had been regarded by the writer as *Colletotrichum incarnatum*, Zimm.* The chief point of distinction between these two species seems to be that the conidia of *C. incarnatum* stain blue with iodine while those of *C. theobromicolum* do not react in that way. The conidia of *Colletotrichum* from cacao pods have stained only yellow when tested, but, again, conidia from a specimen of *Colletotrichum incarnatum* on *Coffea robusta* kindly sent me from Ceylon by Mr. Petch, did not stain blue when tested. The morphological differences between *coffeanum*, *theobromicolum*, and *incarnatum* seem to be too slight to justify their separation into distinct species. Perhaps the foregoing remark should be extended to include other two cacao species, viz., *C. luxificum*, van Hall and Drost, and *C. Cradwickii*, Ban. *Colletotrichum theobromae*, Appel and Strunk, described on cacao pods from Victoria, seems to stand apart inasmuch as its conidia are distinctly smaller than those of the fungi mentioned.

Further evidence of close relationship between *coffeanum*, *incarnatum* and *theobromicolum* was obtained as follows : Conidia of *Colletotrichum coffeanum* in pure culture (derived from coffee berries) were inserted under sterile conditions in wounds made

* Cf. Petch, Circs. & Agric. Journal, R.B.G., Ceylon, 1910, v. 13, p. 147.

in cacao pods by cutting and raising pieces of tissue. After inoculation, the raised tissues were replaced, and the parts were kept moist with sterile cotton-wool soaked in sterile distilled water. After four days, mycelium appeared aerially around the edges of all the inoculation cuts (sixteen in number), and, after ten days, conidia of *Colletotrichum* were present in numbers on both sides of the cuts. After a further ten days, caespitose perithecia of *Glomerella cingulata*, S. and v. S., developed on the site of the *Colletotrichum* acervuli. Control pods, wounded as above, did not show any fungus growth. Similarly, cacao twigs were inoculated with *Colletotrichum* conidia in wounds. In their case, growth of the inoculum was slower than in the case of the pods, but the results were the same. Conidia were also placed on unwounded surfaces of pods and twigs, but, although they germinated freely and produced numerous appressoria, no penetration of the unbroken surfaces resulted. *Colletotrichum coffeanum* was thus proved to be capable of vigorous growth on cacao material. Its effects were indistinguishable from the usual pod-rot of Uganda, and the *Colletotrichum* and *Glomerella* on the pods and twigs were morphologically indistinguishable, the former from *coffeanum* or *incarnatum*, the latter from *Glomerella* on coffee twigs. Conversely, *Glomerella* ascospores from a cacao-pod when sown in prune-agar plates, gave an aerial mycelial growth in forty-eight hours, which was succeeded in five days by conidial formation, the conidia being identical with those of *Colletotrichum coffeanum*, and the same ascospores when inoculated direct into wounds in cacao-pods gave fifty per cent. positive results with the production of *Colletotrichum* conidia in abundance. Ascospores placed on pods germinated but did not penetrate the unbroken skin.

Further work consisted of the transfer of *Colletotrichum* conidia direct from rotted cacao-pods found on trees to agar plates and tubes, and the employment of the resulting cultures to inoculate coffee leaves. The behaviour of the fungus in these cultures was exactly similar to that of the coffee *Colletotrichum*. Sixteen inoculations were performed with *Colletotrichum* conidia, and, in every case, positive results followed. An asetose *Colletotrichum*, indistinguishable in other respects from *Colletotrichum coffeanum*, was recovered from all. Controls remained healthy. Thus the cacao-pod *Colletotrichum*, whether *incarnatum* or *theobromicolum*, was shown capable of infecting coffee. The conclusion to be drawn from the cross-inoculation results and cultural evidences is that *C. coffeanum*, and either *C. incarnatum* or *C. theobromicolum*, or both, are, if not the same species, closely related forms which vary under natural conditions. If distinctions are to be preserved between them, they would seem to be of a physiological rather than a morphological nature, and to be based on the existence of physiological varieties within the morphological species. The conclusion from the succession of forms mentioned above, viz., *Colletotrichum* conidia and *Glome-*

rella perithecia, and vice-versâ, is that the former is the conidial stage of the latter.* It might be mentioned here that the few attempts made to infect *Coffea robusta* and *Coffea excelsa* with conidia from cacao *Colletotrichum* have been unsuccessful.

B.—Colletotrichum on Tea, Cotton, and other Plants.

Colletotrichum on Tea.—*Colletotrichum camelliae*, Mass., the fungus causing Brown Blight of tea, is to be found in Uganda on leaves of all ages. The *Glomerella* stage has not yet been encountered in nature, and the fungus has not been studied in pure culture.† The small areas of tea in the country are of the nature of experimental plots rather than commercial enterprises, and little attention has been given to them. An opportunity, however, was taken recently to inoculate some young tea plants with *Colletotrichum* conidia taken from cultures derived from both coffee and cacao material. Conidia were placed on the apical bud of the stem, and introduced into the stem by punctured wounds, were placed on nodes and internodes of stems and also brought into contact with the nodal and internodal cortical tissues by means of wounds, and were placed on both surfaces of leaves. During a necessary absence of the writer from headquarters, the two series of experimental plants became mixed with the control plants. Results were thus rendered valueless; they were, however, very few. It was only in the case of three plants out of twelve which were inoculated by internodal or nodal wounds that shrivelling of the young leaves and blackening of the inoculated stems were followed by the recovery of *Colletotrichum in vitro*. The conidia of the recovered fungus measured only 10–13 × 4 μ and there were no setae. The leaf-inoculations seemed more successful, but could not be taken into account. It is thus impossible to assert that the tea *Colletotrichum* stands in the same relationship to *Colletotrichum incarnatum* or *C. coffeanum* as *C. incarnatum* does to *C. coffeanum*, but it ought to be noted that, morphologically, *camelliae* is as similar to *coffeanum* as *coffeanum* to *incarnatum*.

Colletotrichum on Garden Plants and Cotton.—Species of *Colletotrichum* have been found on garden plants of *Codiaeum* and *Eranthemum* which were dying back. They are morphologically similar to each other and to *C. coffeanum*, but no cross-inoculation tests have yet been made in order to eludicate their relationships with each other or with the fungus found on coffee.

Anthracnose of cotton-bolls is responsible for a certain amount of yearly loss in the cotton crop of Uganda. The causal fungus is usually confined to the bolls, and it may so penetrate

* Cf. Dastur. Annals of Appd. Biology, VI. 4, 245, 1920.

† The Brown Blight of tea in Assam, from which Massee's original material came, has been shown by Tunstall (*see* Proceedings of the Second Meeting of Mycological Workers in India, p. 56, Board of Agriculture in India, 1919) to be caused by *G. cingulata*, the perithecial stage having been obtained in cultures.

them as to cause rotting of seed and lint. It also causes malformations and premature bursting and cracking which result in the spoiling of the lint through the entrance of other agents besides the anthracnose fungus. The fungus at work is *Colletotrichum gossypii*, South. Its complete stage, *Glomerella gossypii*, Edg., is to be found only at times, for the conidial condition is much more common than the ascomycete. At the end of the cotton harvest in Uganda, it is compulsory for all growers to remove and burn all the plants, and in this way the ravages of this boll disease are kept within bounds. The old custom among native cotton growers of opening up new land for each sowing season is being departed from, and it is therefore to be expected that boll-anthracnose will increase in severity rather than decrease, especially when the annual burning is carelessly carried out. No data are available as to the resisting powers of the different strains of cotton in the country, but observations made would point to all as equally susceptible.

Gloeosporium spp. **on Bananas and Hevea.**—*Gloeosporium musarum*, Cke. and Mass., is to be found at times on ripe bananas. It causes black spots on the fruit which eventually lead to a complete rot. This fungus would be responsible no doubt for a much greater loss of native food-stuff than it has been hitherto, were it not for the fact that the native cuts and cooks his food bananas while they are still unripe and green. *Gloeosporium albo-rubrum*, Petch., occurs on green shoots of *Hevea*, and causes them to die back. It is in this way responsible for the entry into the tree of *Botryodiplodia theobromae*, Pat., which attacks the older woody branches and often makes necessary severe amputation before its ravages can be stopped. *C. alborubrum* is frequently found in close association with *Phyllosticta ramicola*, Petch.

Other species of *Colletotrichum* (*Gloeosporium*) occur on mangoes, guavas, pomegranates and species of *Citrus*, but they have not yet been investigated.

C.—Phoma spp. on Coffee and Hevea.

Phoma sp. **in pure culture.**—It has already been mentioned that *Phoma* sp. occurring, as it does, frequently on coffee stems was considered to be implicated in the production of dieback of coffee, and was grown in pure culture. The minute black pycnidia of this fungus extrude yellow-red " tendrils " of spores after from ten days to a few months in a damp chamber. The pycnospores germinate readily in coffee-leaf or prune-agar plates and slants at laboratory temperature. Aerial septate mycelium, at first white but becoming dark grey with age, appears in concentric arcs stretching across the surface of the medium, and globular, thick walled conidia of a diameter of 12·5–17·5 μ, when young, hyaline, and when mature, dark-brown or black, appear first. They are cut off terminally from the mycelium,

the cell behind the conidium being slightly bulbous or swollen. These conidia were found to germinate slowly in from six to nine days in hanging-drops of distilled water, and to give rise to secondary thin-walled conidia which germinated readily and produced further thin-walled conidia which in turn pushed forth delicate hyaline germ-tubes. The secondary conidia may themselves become dark in colour, and form, along with the original conidia, a *Coniothecium* stage of the *Phoma*. This *Coniothecium* form has been found on coffee twigs, but never, to date, in the tissues. No further stage in its development has been observed.

Pycnidial formation takes place after the lapse of six weeks. The conidia or pycnospores are continuous, hyaline, though red-yellow in the mass, elongated, up to 5 μ by 1 μ in breadth, and guttulate. The coniodiophores are half the length of the conidia. Pycnospores in nature measure 4·5 μ by 1·5–2 μ, are elongate-ovate, the longer spores being the narrower in proportion and are contained in pycnidia which are 2·5 mm. in diameter, black and carbonaceous. In cultures, the pycnidia are smaller, the largest measuring up to 2 mm. in diameter. No ascigerous stage has been found in any of the cultures though they have been kept for over eight months. Chlamydospores appear before pycnidial formation takes place. They are formed by breaking up of the mycelium, and, while at first irregular in shape and more or less hyaline, they eventually become globular, thick-walled and brown. They measure up to 20 μ in diameter. They germinate in drops of rain-water in from fourteen to twenty days. In an old culture, chlamydospores become so numerous that they can be seen by the naked eye as dots in the course of the mycelium.

On sterilised coffee-wood blocks, *Phoma* grows rapidly. Pycnidia are produced in abundance in twelve days. They measure up to 2 mm. in diameter, and their spores up to 5 $\mu \times 2\ \mu$. The *Coniothecium* is also produced in plenty. Microscopic examination of the blocks showed the mycelium of the *Phoma* penetrating medullary-ray elements and pitted tracheids to a depth of 3 mm. in twelve days.

Inoculations with Phoma sp.: **the part played by the Variegated Bug.**—Inoculation experiments similar in all respects to those performed with *Colletotrichum* on coffee were carried out with material from the *Phoma* cultures. Pycnospores or chlamydospores and mycelium were placed on upper and under surfaces of leaves, on stems at nodes and along internodes, and in nodal and internodal wounds of stems. The total number of inoculations was sixty, and of these only one was successful. In it pycnospores had been placed on the unbroken internodal bark of a branch, the apical leaves of which began to droop after two months. Mycelium was found in the branch tissues near the point of inoculation, and *Phoma* was subsequently recovered.

It is difficult to explain why all the *Phoma* inoculations except one were negative, and to reconcile the apparent difficulty

of inducing infection with the actual presence of the fungus in dieback tissues and its proved powers of penetrating coffee-wood blocks, until one takes up the mycological investigation of the insect pests of coffee. Of these one of the most dangerous is the Variegated Bug (*Antestia orbitalis*, Westw. var. *faceta*. Germ.) which punctures and sucks the juices from twigs, buds, and berries. In the study of the broken and chipped beans which on curing are frequently found inside what appear to be perfectly sound-skinned cherries, it occurred to the writer that the fungus found on such "lights" might possibly be introduced by the Variegated Bug.

This theory was put forward in 1916* when the appearance of the Bug in dangerous numbers coincided in time with the occurrence of the broken beans. Then, as now, pycnidia of the same species of *Phoma* as is found on the branches were invariably found on small "cankers" on the cotyledons. In order to throw light on this supposition, legs and beaks of the Variegated Bug were taken from the insects with sterile forceps, shaken up in prune-agar and sugar-cane agar, and poured into plates. In all the cultures, except one which was productive of bacteria and moulds only, *Phoma* mycelium appeared aerially in forty-eight hours. None of the cultures was pure in the sense that it contained a growth of one species of fungus or bacterium only, for the *Fusarium* sp. was found in sixty per cent., moulds in eighty, and bacteria in twenty per cent. If, as appears probable from these facts, the Bug carries the spores of *Phoma* in or on its beak, that is, in or on the organ it introduces into tender tissues in order to suck, it is to be concluded that this pest is to blame not only for the broken beans but also for the presence of *Phoma* in tissues which it may be incapable of penetrating without the help of an outside agent.

It is somewhat remarkable that *Colletotrichum* was altogether absent from these Variated Bug beak and leg cultures, but this may have been due to the circumstances of the moment. Again, no other pest from among the seventeen scale insects known on Uganda coffee, or the aphids, or other plant bugs (*Lycidocorus mimeticus*, R. and P., and *Piezodorus pallescens*, Germ.) or borers, etc., has been examined on these lines, and there may be no reason why all or any one of these should not carry and introduce into attacked tissues both *Colletotrichum* and *Phoma*. The former *alone* has developed on obviously bug-smitten branches, but it may have been present as a saprophyte, for numerous acervuli of *Colletotrichum* will develop on previously healthy fresh branches when plucked and kept in the damp. Similarly, *Phoma* pycnidia can be found on healthy branches, apparently causing no harm and probably lying in wait, as it were, to initiate a vigorous attack on the weakening of the tree owing to the results of unfavourable conditions such as leaf-disease,

* Small: Notes on a few Ug. diseases of plants, Ug. Pl. Assn. Yr. Bk. 1916–17, p. 135.

unsuitable climatic conditions, or overbearing. Inoculation results indicate that *Phoma* by itself is by no means an aggressive parasite, and there is, further, no Uganda evidence of such a *Phoma* disease of coffee as that described by Dowson in British East Africa.* The recommendations made with regard to the coffee dieback with which *Colletotrichum* and *Phoma* are implicated consist of measures designed to produce a healthy and resistant tree.

Phoma on Hevea.—The only other species of *Phoma* found on a plant of economic importance is *Phoma heveae*, Petch, which occurs on *Hevea* branches, apparently without causing any harm.

VI.—THE AGRICULTURAL DEPARTMENT, DOMINICA.

A. Keys.

We have received the following interesting account of the development of the Agricultural Department, Dominica, from Mr. A. Keys, the Assistant Curator of the Botanic Gardens, Dominica, who was sent out from Kew in the early summer of 1919 (K.B. 1919, p. 237).

We are glad to be able to publish this useful record, especially as it enables the valuable and devoted labours of Mr. Joseph Jones to be more fully appreciated. Mr. Jones left Kew to take up his appointment as Curator of the Botanic Station, Dominica, in March, 1892.

It may be said in connection with the Agricultural Department of Dominica that, since its humble beginning as a Botanic Station 28 years ago, its progress has been rapid and its functions useful. Further, it has taken into account every important section of agriculture constituting the work of a department worthy of the name; always with due regard to the requirements of this wonderful Island.

In giving a few notes of things " past and present " relative to the Gardens and their surroundings, it will be as well to start with the Botanic Gardens proper which gave birth to the present Agricultural Department.

The Botanic Gardens.

The Botanic Gardens, Dominica, might well be described as a miniature Kew : their object is the same in the sense that they were established to further the interests of agriculture, and their position amongst other gardens of the West Indies is comparable to that of Kew in Europe; but they do not possess a herbarium and cannot boast of glass houses or museums.

The Gardens in Dominica, like most others of their kind can only rank as an " outpost " or a link in the chain of establishments

* Dowson : A new disease of coffee; Leaflet No. 1, Div. of Mycology. Dept. Agric. B. E. A., October, 1917.

reaching out from Kew to the farthest ends of the Empire, each one of which serves a similar purpose within its own particular sphere. Kew—the "mother" of all the smaller establishments—stands supreme. It occupies a central position, and is suitably equipped for a far wider range of activities, keeping the smaller gardens in touch with one another, and helping them out of such difficulties as establishments on a less pretentious scale are sure to encounter.

Much might be said of the relations which have existed between Kew and the "outposts" since its very beginning, but to most of us the excellent results that have accrued from this intimate connection are well known, and one has only to look back on the modest beginning of the Rubber, Cinchona, and other important crops initiated by Kew, and which to-day rank amongst the most important and flourishing of all tropical enterprises, to appreciate the true value of the work that has been accomplished.

Then again Kew has sent out her "sons of the soil" to play their part in this important work, and from all accounts one might safely say that "they have done well."

It is hoped that the following short account of the history and progress of the Botanic Garden, Dominica, from their commencement in 1889 up to the present time, will serve as an example and show the interesting developments and the results possible of attainment with proper care, foresight, judgment, and perseverance, coupled with such valuable assistance as Kew alone is able to give.

The first steps towards the establishment of a Botanic Garden proper in Dominica were taken near the close of the year 1889, when Mr. Charles Murray of the Edinburgh Botanic Garden was appointed Curator.

In 1890 Mr. Henry F. Green of Kew succeeded Mr. C. Murray, who had been transferred to Grenada, and it was to Mr. Green that fell the work of beginning the laying out of the grounds of the present garden.

But, like his predecessor, Mr. Green was not destined to remain in Dominica; in 1892 he resigned and was succeeded by the present Curator, Mr. Joseph Jones of Kew, who, since his appointment in that year, has laboured without intermission and to-day can look back over 28 years' endeavour, the early stages of which must have called for much "spade work" to bring the department to its present state of beauty and utility.

Mr. Joseph Jones, as is usually the case with men who achieve great things, is exceedingly modest, and those who seek an account of things as they were in the early days need not refer to the excellent official guide of the Garden prepared by him, for they will be disappointed therein.

Beyond a short history of the Garden, nothing will be found in its pages to throw light on the formidable task and the difficulties that must have been encountered in the work of converting a rough piece of ground into a Botanic Garden.

Details of this kind, recounting the struggles of one who set out to make the best of things, must be patiently waited for until they fall unconsciously, one by one, from the lips of him who so modestly tries to hide them.

One instance may be mentioned where an interesting fact was revealed to me in this manner. This happened whilst discussing with Mr. Jones the merits of a large Bougainvillea, when I noticed, hidden beneath the bush, a huge stone measuring about 6 square feet. This, I was informed, was one of the many stones that were found on the ground when the Government bought the site, and had been preserved as a relic of those days; the others having been blasted out and used in the building of the wall that now separates the Garden from the public road, running from the Emsall Gate to the Curator's Gate, a distance of several hundred yards. This gave me ample proof of the original state of the ground, over which now stretches a beautiful lawn and, where the depth of soil has permitted, large trees are in a flourishing condition.

Contrary to what might be expected succulents do remarkably well in that Garden considering the heavy rainfall, even in this part of Dominica, which averages for the last 28 years over 78 ins. per annum. Up in the interior the precipitation may be as much as 300 ins. per annum!

A plant of *Cereus peruvianus* is now 35 ft., and, strange to say, withstood the hurricanes of both 1915 and 1916; it gives some idea of the success attending the cultivation of succulents in Dominica.

The situation of the Garden may be said to be ideal, for it stands on a comparatively flat piece of ground distant about 500 yds. from the sea, and immediately under the precipitous Morne Bruce.

The area of the Garden is approximately 42 acres, exclusive of nurseries, and a lime experiment station and other grounds, to be referred to later.

The Morne Bruce cliff, which rises to a height of 300 ft., gives to the Garden a wonderfully picturesque setting, and with its two spurs projecting at each end into the Garden forms a charming amphitheatre of greenery. This half circle takes in the whole of the eastern boundary and affords protection from prevailing winds.

During the flowering periods of native and exotic trees which have been planted up this slope, the colour effect produced by the mixture of these with shrubs and bushes of various shades of green, together with palms and bamboos waving to and fro in the breeze, presents a picture of rare beauty. It is difficult to describe the beauty of this slope. At the time of writing this the date-palms, with their greyish-blue* leaves and half ripe

* Owing to the bloom, which gives to the leaves a decidedly greyish blue tint the writer had some difficulty in recognising the trees after having seen date-palms in Egypt.

yellow fruits, stand out in wonderful relief from the different shades of green, as do also the specimens of *Livistona chinensis* and *Washingtonia filifera*. The latter tower about 80 ft. in the air!

In addition to the contrast afforded by the palms with their masses of dead leaves neatly clustered round the base of the "head," the beautiful Bougainvilleas greatly enhance this wonderful blend of colour.

Ornamental Section.—The Garden is divided into two parts. That part known as the ornamental section is marked off from the economic section by a low wooden fence and occupies most of the flat land.

The lawns are extensive and well kept; the main lawn, which is used for cricket and boasts a pavilion, being over 2 acres in extent. Bounding this lawn on three sides are huge specimens of the Saman tree, (*Pithecolobium Saman*), on which are growing native and exotic orchids.

To complete the square on the east side of the lawn a border of mixed low-growing ornamental shrubs was planted instead of continuing the tall Saman trees, for this side of the lawn faces the forest-clad mountains of the interior, which give a distant background of great natural beauty.

The collection of flowering trees and shrubs, palms and other ornamental plants such as *Pandanus* spp., Bamboos, Conifers, succulents, &c., includes all the best and most showy kinds.

Such handsome trees as *Baikaea insignis* and *Steriphomia paradoxa* adorn the lawns. The collection of palms includes over 100 species!

A row of Cohune palms (*Attalea cohune*), planted near one of the gateways, have grown to a height of 40 ft. and attract a good deal of attention.

Palms have been planted singly, in bold mixed groups, and to form vistas.

The Talipot palm (*Corypha umbraculifera*), of which there are several specimens in different stages of growth, stands out distinct from all other palms that have been planted singly. The palms that have been planted in vistas include *Pritchardia pacifica*, *Raphia vinifera*, *Oreodoxa oleracea*, and *Caryota urens*.

The vista formed of the *Caryota* includes plants of all ages and stages of flowering, and is of special interest to those who know of the peculiar flowering habit of this palm. On reaching maturity it throws out an inflorescence from the top of the tree, continuing downwards from each axil, until the palm is exhausted, and dies. For the most part, with the exception of large trees, planting has been done in the group system.

Among those plants that have been so planted may be mentioned various Crotons, Hibiscus, and Pandanus; *Duranta Plumieri*, *Golphimia brasiliensis*, Gardenias, Tabernaemontanas, Aralias, and other plants.

Bougainvilleas, as well as the handsome climber *Norantea guianensis*, have also been planted in beds and kept trimmed to

give a dome-shaped appearance. The latter plant is particularly attractive during March and April, when it throws out spikes of red flowers, the spikes measuring in length from 2 to 4 ft.

Among the trees planted singly are included several timber and other trees which give excellent shade, but do not possess much value in floral beauty. They have, however, their place in the collection and add charm to the grounds.

Included among these trees are species of *Ficus* such as *F. elastica*, *F. Vogelii*, *F. altissima*, and *F. Benjamina*.

These trees, which have now reached huge dimensions, are growing here and there throughout the grounds, and afford excellent shade during the heat of the day to those who feel disposed to use the seats placed thereunder.

Flowering trees and shrubs such as *Amherstia nobilis*, *Saraca indica*, *Swartzia grandiflora*, *Tabebuia pentaphylla*, *Alstonia scholaris*, *Cananga odorata*, *Butea frondosa*, *Colvillea racemosa* and *Melaleuca Leucadendron*, along with several species of *Brownea*, *Ixora*, and *Bauhinia*, are among the best and do remarkably well.

Among the most important trees and shrubs grown on account of their ornamental fruits may be mentioned "The Sausage Tree," (*Kigelia pinnata*); *Dillenia indica*; "Jack Fruit," (*Artocarpus integrifolia*); "Cannon Ball Tree," (*Couroupita guianensis*); "Velvet Tamarind," (*Dialium guianensis*); *Kopsea fruticosa*; and *Carissa Carandas*.

Poinciana regia, and several species of Cassia, as well as *Lagerstroemia Flos-Reginae* and *L. indica*, and its variety *alba*, all have a place in the collection and give a wonderful display of colour in their respective seasons.

Creepers do exceedingly well and beyond keeping them in proper limits are left to take care of themselves. They include: *Beaumontia grandiflora*, *Camoensia maxima*, and *Aristolochia gigas* var. *Sturtevantii*.

Catalpa longissima, a West Indian tree, is used in these Gardens for creepers to grow upon and seems particularly well adapted to carry and display the Bougainvilleas.

In addition to the many varieties of the purple Bougainvillea, *B. laterita* (terra cotta) and a new introduction from Brazil by Mrs. Butt of a gorgeous free-flowering species, named after that lady, are also plentiful and thrive equally as well as the more common type.

Of the Conifers, *Juniperus bermudiana*, *Cupressus glabra*, *Pinus bahamensis*, *Araucaria Bidwillii* and *A. brasiliensis* do the best.

Economic Section.—On entering this section one's attention is attracted on all sides by the wonderful collection comprising most of the principal economic plants of the tropics.

Even the Date Palm of the sandy deserts, and the "Shea Butter Tree" (*Butyrospermum Parkii*), of Africa—probably the largest specimen outside that continent—are represented here.

The Citrus beds contain all the best kinds of oranges, Tangerines, Grape Fruits, Shaddocks, Pomelows, Lemons and Limes.

Several kinds of Coffee are grown, the two principal Vanillas, Cola nuts, most of the recognized rubber trees including the Landolphias, Nutmegs, Cinnamon, Camphor, Mangoes, Mangosteens, Durians, and other trees and plants of medicinal or other use to man.

Cocoa covers about 7½ acres of ground and is planted in ¼ acre plots, each of which receives different treatment in the two series of manurial experiments started in the years 1900 and 1907 respectively. Some of the plots occupy flat land, whilst the others are situated on the Morne Bruce slope.

This slope is typical of the rugged character of the land on planter's estates in different parts of the island, and on this account was selected for some of the plots to ascertain the manurial requirements of cocoa growing elsewhere in similar situations; as well as for comparing the results with those obtained from the plots on level ground.

To skim over things, as one must needs do in a paper of this kind, scarcely does justice to such an important part of agriculture as manurial experiments prove to be. It may, however, suffice to mention here that the experiments have been splendidly conducted and records carefully kept. At the time of writing the results of 20 years' work on the manurial experiments of cocoa are about to be published in the Annual Agricultural Report, and to all those who are interested in this crop they should furnish much valuable information.

Apart from the interesting results, these experiments have the additional merit of being the only ones of their kind conducted over such a long period of years.

It may be interesting to mention under this head that the crops from the cocoa plots, lime experiment plots, together with miscellaneous fruits and spices from other economic plants in the collection are a source of considerable financial support to the Department.

The receipts under the various heads for the year ended March 31st, 1920, were as follows :—

	£	s.	d.
Limes	625	6	7
Cacao	395	14	2
Nutmegs	15	12	10
Cola Nuts	12	8	1
Plants	113	7	2
Fruit	26	12	7
Vegetable seeds	13	16	9
Cassia Pods	10	7	11
Miscellaneous	7	13	6
	£1,220	19	7

Nurseries.

The raising of plants at cheap rates to supply the needs of planters constitutes the work of this important and useful branch of the department. Here the planter can obtain at a small cost all the plants he may require for his estate, and is thus saved the trouble and inconvenience of having to provide them for himself.

To the new planter in particular these nurseries are of special value, for he is able to obtain a supply of young plants at any time to plant up his newly cleared forest land, which means a gain to him of at least 12 months in the case of lime plants, and nearly 2 years should he decide on budded trees of either Citrus or Cocoa.

With a steady increase in the demand for plants it became necessary in 1907 to extend the nurseries by taking in the only available piece of ground, which is situated on top of the Morne, and using it solely as a lime nursery; keeping the main nursery situated on a level with the Botanic Garden for budded Citrus, Sugar cane, Rubber, Coffee and miscellaneous stock, and such lime plants as might be required to supplement the principal supply at the Morne to meet the requirements of planters. The total area of these two nurseries is a little over 6 acres, in addition to which there is a shaded nursery where Cocoa, Nutmegs, and choice fruit trees such as grafted Mangoes, Mangosteens, Durians, &c. are grown in bamboo pots.

Near by stand two glass-roofed propagating houses with open sides used for raising seeds of a delicate nature and seeds which, if sown in the open ground, would be devoured by rats and birds.

The shaded nursery referred to above is of the ordinary type used in the tropics, consisting of a light frame work of wood, with a covering of wire netting, over which creepers are encouraged to grow to provide the necessary shade; the whole structure being supported by posts placed at regular intervals.

It may be mentioned that a section of this nursery is always kept stocked with large specimens of palms, flowering trees and shrubs, and economic plants growing in boxes ready to plant out in the places of those that may be blown down by a hurricane. .

It is difficult for anyone to imagine the damage that can be wrought by a hurricane until he has seen the after-effects, or worse still, experienced one for himself.

The hurricanes of 1915 and 1916 did considerable damage. Apart from damage done in other parts of the island, where in some cases the tops of dense forests were blown away and huge trees and boulders washed down into the sea, the collection of trees in the Botanic Garden was so smashed up as to make the place almost unrecognisable to anyone who had seen it a few hours beforehand. So great was the damage that a special vote of money had to be expended in clearing up the grounds. In the Lime Experiment Station a whole series of experimental

plots was completely wiped out, many of the lime trees being carried away by the flood, whilst others were deposited on adjacent land.

In connection with nursery work in the tropics, the humus question demands careful attention. With the strong rays of a tropical sun beating on exposed land the humus of the soil is soon destroyed, and in order to prevent this it becomes necessary to provide a covering of mulch consisting of dried grass and leaves. The mulch not only serves as a covering, but eventually decays and thereby increases the humus content of the soil.

The nursery beds adjoining the Botanic Garden receive most of the cut grass from the lawns as well as leaves and other vegetable matter; whilst those at the Morne are supplied with dried grass from surrounding waste patches of land.

The method followed here where lime seedlings are grown on the same piece of land year after year is as follows :—the beds and the paths running between them are made the same width, the path being filled with cut grass which eventually decays; the following year the paths, in which the grass has been trampled under foot and thereby converted into a more or less decaying mass, are dug up and converted into beds, the beds of the previous year being made into paths. In this way the ground serving as paths for one year receives a good dressing of organic matter, and is rested for a period of 12 months.

In order to show the extent of the nursery work, a table of the yearly distribution of plants from 1905 to 1920 is given below :—

1905–6	65,731	1913–14	58,198
1906–7	83,000	1914–15	67,042
1907–8	53,855	1915–16	65,700
1908–9	67,596	1916–17	53,640
1909–10	79,009	1917–18	45,518
1910–11	69,295	1918–19	32,609
1911–12	76,363	1919–20	55,837
1912–13	75,146		

The average annual sale of plants during the above period is 63,236. In normal times, however, taking the period from 1905–6 to 1914–15, the average annual sale of plants was 69,523. During the war, as the above figures show, the annual sale of plants gradually decreased owing to the absence of many of the planters from the island who left to join the army.

In addition to nursery plants there is also a considerable distribution annually of seeds of rubber, coffee, green dressings, fodder grasses, shade trees, papaws, and vegetables.

Agriculture : Influence of Nursery Work.—Apart from supplying the immediate requirements of planters there has always been the experimental side of the work for the future improvement and welfare of the island.

Past experience of the coffee industry in Dominica, when this crop occupied a similar position to that of the Lime of the

present day, has shown that the practice of planting one crop to the exclusion of all others is one to be avoided. Up to that time limes, the present staple crop, had not been thought of in Dominica; indeed, sugar seems to have predominated after the failure of the coffee crop, and limes only came in gradually with the decline of the sugar industry, when beet began to take an important place in the world's supply of sugar, and the price of this commodity fell below the cost of production.

The agricultural history of Dominica from the coffee days shows that the dangerous policy of placing all one's eggs in one basket was adopted. And bearing in mind how much the future welfare of the island may depend upon securing suitable alternative crops and thereby avoiding a repetition of such a disaster as overtook agriculture in the coffee days, the importance of this nursery work will be understood.

Of late years cocoa planting has been encouraged by the department and every attempt made to extend its cultivation to districts which, prior to experimental work commenced on this crop, were considered unsuitable.

The superior Criollo type refuses to thrive in any part of the island, but it has been shown, after much pioneer work on the part of Mr. Jones in the budding and grafting of cocoa, that a good medium grade of cocoa can be grown in any part of the island, where cocoa might reasonably be expected to thrive, by grafting the Forastero type on the hardy Calabacillo stock. The Calabacillo type of cocoa in itself yields a very inferior grade of produce, but its immunity from disease, as well as its indifference to soil and climatic conditions, makes it invaluable as a stock for grafting; as by this means a medium grade of cocoa can be grown in places where the Forastero on its own stock would give poor results, and where the superior Criollo would possibly fail altogether.

Experimental onion growing was started a few years ago with a view to encouraging the cultivation of this crop to supply local needs. As an inducement to get planters and others to take an interest in this departure from orchard cultivation, seeds were imported from Teneriffe and sown in the nursery and the seedlings distributed free of charge.

Since the commencement of the experiment the demand for seedlings has rapidly increased. Following the lead of a successful grower several other planters have now come forward and placed definite orders with the Department for the purchase of onion seed to make them independent of the limited distribution of seedlings. Onions have become a remunerative crop, and local needs having now been satisfied, it is gratifying to note that another item has been added to the list of exports.

Buildings.

All the buildings, with the exception of stables and cart sheds, are situated near the Curator's office. In the Curator's office

space has been allotted to accommodate a very comprehensive and useful library.

Adjoining the office is a small but well equipped laboratory. Near by stands the class room, Foreman's house, tool and packing houses, potting shed, two propagating houses and a fumigator; the latter being used for imported seeds and plants which, when necessary, are brought straight from the Customs house and fumigated before the importer is allowed to take possession.

A few yards further away is situated a meteorological shed, and a cocoa drying house. The latter is of the ordinary type with sliding trays and a furnace to supply artificial means of drying when wet weather necessitates the trays being pushed back under cover. A considerable quantity of cocoa, nutmegs, and cola nuts, passes through this house in the course of a year.

Agricultural Instruction.

The present day system of agricultural training takes the place of the more elaborate provision of 20 years ago, when a grant of money from the Imperial Government allowed of from 20 to 25 boys being trained and accommodated in the old military buildings at the Morne. In those days the pupils, under the charge of an Agricultural officer of the Department, were fed and clothed and schooled in general agriculture, as well as in subjects of an elementary education, for which a schoolmaster was employed. Field work commenced at 7.30 a.m. and at 11 a.m. the boys were brought in and placed under the care of the schoolmaster until 4 p.m. when all instruction for the day came to an end and the boys were encouraged to take part in games and sports organised by the officer in charge.

It is interesting to record that at that time pedigree animals were kept for stud purposes and the care of these animals together with school gardens, and bee-keeping formed part of the boy's agricultural training.

The stock included :—

Horses, Donkeys, Cows, Sheep, Goats, Pigs, Rabbits, and Poultry.

The grant made by the Imperial Government for the upkeep of the Morne school was withdrawn in 1910, and, as the local Government was not in a position financially to take over the school and continue the good work on a similar scale, it became necessary in that year to dispose of the stock and close the buildings. The need of a system for training the youth of the island in agricultural methods after the closing of the Morne school was met by the local Government in 1911, when a small class room was erected in the Botanic Garden, and six boys were admitted as pupils for a period of two years. This system of training started in 1911 is in force at the present time.

When new pupils are required to take the places of those who have completed the course, an advertisement is inserted in the

local papers inviting candidates to present themselves at a competitive entrance examination, which is held by the Superintendent of Agriculture at the Botanic Garden. The pupils are then examined in the elementary subjects of a seventh standard public school, whereby some idea of their fitness to receive the agricultural course of training is fairly well ascertained.

The field work performed by the boys is of a light but useful nature, consisting of: Pruning lime trees, dressing wounds; mixing and applying insecticides and fungicides; sowing green dressing seed; budding limes; applying manures; pollinating vanilla flowers; planting nursery beds; potting cocoa, &c.

Practical demonstrations on tapping *Hevea brasiliensis*, and preparing rubber are also given. During their course of instruction in practical agriculture, the pupils are always under the supervision of an officer of the Department.

The subjects of class instruction are :—

Air and Water.
Soil and Drainage.
Manures.
Pests and Diseases of Plants.

Agricultural Botany.—Pollination and Fertilization, Elementary Physiology, pruning, grafting and budding, and other means of propagating plants.

Economic Botany or the cultivation and preparation of the principal economic products of the tropics with special reference to the West Indies.

The object of the agricultural training given to pupils is to fit them for taking up positions either as overseers or managers on planters' estates.

Many of the boys are the sons of peasant proprietors, and very often after completing the course of instruction at the Botanic Garden they return home and help their parents until old enough to take up planting on their own account.

Many such boys who have taken up planting have done remarkably well. The successful onion-grower referred to in a previous paragraph was at one time an agricultural pupil; to-day he is a prosperous planter, and a walk through his estate would convince the most sceptical of the benefits to be derived from a sound training in agriculture. Unlike many others, this planter believes in having more than one string to his bow, for in addition to Limes, Cocoa, Sugar, Coffee, Grape fruits, and Washington navel oranges; such crops as Maize, Onions, and French beans are also grown.

Other Efforts in connection with Agricultural Progress.—Since the inception of the Agricultural Department its energies have been directed to aiding all sections of the planting community.

With regard to instruction in agricultural matters, a Prize Holding Competition to encourage peasant holders was started in 1908. Cocoa was the principal crop grown.

Keen competition was shown amongst the peasants for the first year or two, but gradually their interest declined and fell off altogether in 1913.

With a depletion of the staff during the war, the Department was not in a position to make further efforts towards helping peasant holders, and now that the Lime Experiment Station has become established and very little time and opportunity is available for this kind of work, it has become a difficult matter to deal with; especially when such schemes involve close watching and frequent visits entailing considerable time upon tedious journeys over difficult country.

Courses of reading and examinations in practical agriculture were established under the direction of the Imperial Department of Agriculture for the purpose of enabling overseers on estates and others engaged in the practice of agriculture to acquire knowledge that would be useful in connection with their practical work. The scheme was successful and did much good until agriculture along with other industries was upset and disorganised by the war.

Now, when the war is over, high wages paid in America and elsewhere have had the effect of drawing away from the island many of the returned soldiers and efficient agricultural workers. Consequently the reading courses are still in abeyance and likely to continue so until those concerned show a desire to take advantage of an opportunity of extending their knowledge and fitting themselves for more remunerative positions.

Agricultural Cadet training.—The training which has been given for some years in Dominica and other West Indian islands received a set back in this island at the beginning of the war when the Science Master left the Grammar School.

This system of training is of a much higher grade than that of the ordinary agricultural instruction given to the sons of peasant holders, requiring, as it does, that those boys who wish to become Cadets must receive their education at the Grammar School.

Latin and Science are two subjects between which boys can make their choice after they have reached an advanced stage. Naturally those boys who intend taking up agricultural work select the science training under the Science Master, and thereby get a thorough grounding in such subjects as Chemistry, Botany, &c.

The science training given at the Grammar school is thus part of the cadet system, for as soon as the boys have completed their work at school they enter the Botanic Garden for a period of 12 months to gain an insight into the practical side of agriculture. By special arrangement a cadet may be allowed a further period of 12 months in the Garden if he so desires.

Laboratory Work.—The purpose for which this section of the Department was established has been well served since the erection of the laboratory in 1910.

The idea in fitting up a local laboratory in the Garden was to enable the Department to deal with the analysing of Lime juice, milk and other food stuffs, soils and manures, &c.

The gradual increase in the number of samples sent in for analysis shows that the Government laboratory in Antigua is gradually being relieved, so far as Dominica is concerned, of such work as might be safely and efficiently dealt with locally, with a saving of time and postal expenses.

The laboratory in Dominica, it should be mentioned, does not interfere in any way with the central laboratory in Antigua —supported by the Imperial Government for research work in the Leeward Islands—in regard to the more important chemical investigations. All important matters are still submitted to the Government Chemist in that island and only such work as is shown above has been undertaken locally.

Morne Bruce Lands.

Leaving the Botanic Garden and proceeding along a zigzag path, well protected from the sun by overhanging bamboos and native timber trees, the top of the Morne Bruce cliff is eventually reached.

Having arrived at the top one receives as a reward for the strenuous climb a refreshing breeze from the direction of the Windward coast—a pleasure which the people of the town of Roseau can only experience on the hill tops, for rarely does the wind blow in from the sea on the Leeward side, where Roseau and the Garden are situated.

At this point, looking up the Roseau Valley, the winding river can be seen making its way down from the rugged country above; whilst looking out towards the sea one views immediately below the full expanse of the Garden.

Between the Garden and the sea the red-topped houses and the steeples of churches peep out here and there from among the trees.

The contrast here is very striking; for down below we have the Garden representing purpose and order of things, and up in the country above, in the opposite direction, a wonderful scene of natural beauty.

Keeping straight along the edge of the cliff on the left hand side is a collection of Eucalpyts, which numbered seventy-two species prior to the hurricanes of 1915 and 1916; now, however, after the havoc then wrought the number of species is reduced to about fifty.

The Morne Bruce lime nursery already referred to is situated next to the Eucalyptus plot.

Adjoining this nursery is a piece of ground 2 acres in extent planted in Coconuts, Cocoa, Limes, Camphor, and Rubber,

(*Hevea brasiliensis*). Experimental tapping of the latter is being carried out at the present time.

On the right hand side of the road leading from this point to the Lime Experiment Station stands the Curator's house and Government cottage.

Before reaching the Lime Experiment Station the road passes under an avenue of Date and Coconut palms, and leads into a grass square on each of the four sides of which stands an old military building. These buildings have been used for many purposes since the military vacated them, including those of Reformatory School, Poor house, Isolation Hospital, and latterly as the Agricultural School already described.

Continuing along the road the Lime Experiment Station comes into view on the right. Standing on the road—only a few feet wide—which may be described as the crest of the ridge separating the Roseau valley from the valley in which the limes are growing, one obtains not only a good view of the Experiment Station below but also of the scenery of the rising land beyond.

As a rule the peaks of the tallest mountains are buried in the clouds, but on fine days, especially in the evenings, they stand out well defined against the clear sky.

Lime Experiment Station.

The area of the Lime Experiment Station is approximately 25 acres exclusive of the lower part of the valley near the sea, which is also Government ground and will be taken into cultivation gradually and planted with limes. In addition to Limes, Camphor, Coconuts, Grape fruits, Shea Butter trees, and green dressing crops are also grown.

These crops, however, do not take up much more than 9 acres of land; whilst the growing of green dressing crops is essential for mulching purposes in connection with the manurial experiments.

The mulch crops are grown on shallow patches of land near the mulch plots of each of the series of experiments, and they serve two purposes, viz.—supplying mulch to lime trees and demonstrating to planters how shallow patches of land in the vicinity of lime cultivations may be utilised.

The Lime Experiment Station has been in existence for seven years. Started in 1913 it took the place of a rather unsatisfactory system of experiments that had been in vogue on several estates in different parts of the island since 1901.

The need of undertaking experiments in the cultivation and manuring of limes had long been recognised; but no useful attempt was made to meet this need until 1913, when it was found that the many pickings involved, labour troubles, and inadequate supervision on estates stood in the way of accurate records being furnished. It became evident that the problem could only be solved by bringing together the whole of the plots

into one area, and conducting the experiments on sound lines under the direct management of the Agricultural Department. Fortunately the Government possessed land suitable for this purpose in the valley beyond Morne Bruce within easy reach of the Botanic Garden. This land is sloping in character and typical of conditions of large areas where lime cultivation in the island is carried on.

A distinct advantage which enabled experiments to be commenced almost at once was the existence on this piece of land of a considerable number of lime trees that had been planted in the year 1893 by the boys of the Reformatory school at Morne Bruce.

From the time of planting in 1893 the lime trees were properly cared for until the closing of the institution in 1895, when they were abandoned and allowed to become overgrown with bush a condition which lasted until 1913, the year the Agricultural Department took over the land for experimental purposes.

Naturally the trees were found to be poor in condition and attenuated in appearance, but it was seen at the time that with a certain amount of trimming and proper attention given to drainage, they would soon pull round and develop into good healthy bearing trees.

Faulty planting necessitated many of the trees being permanently removed, whilst in some places fresh trees had to be planted to make up the plots with trees planted at suitable and equal distances apart.

All this had to be done before the plots could be lined out and manurial treatment commenced. Meanwhile, a patch of old pasture land near by was being planted with young limes and marked off into eight $\frac{1}{4}$ acre plots; the object being to duplicate with the young cultivation the experiments carried on with the older trees, thus confirming or otherwise the results. Further, it was hoped that the results would show to what extent old lime trees were capable of responding to manurial treatment.

It was intended that the experiments should be conducted in two series :

Series 1. With old trees (8 plots).
,, 2. With young trees (8 plots).

The scheme of manuring is outlined below :—

1. Complete manure.
2. Control—no manure.
3. Mulched with grass and leaves.
4. Nitrogen only (Sulphate of Ammonia).
5. Nitrogen only (Dried blood).
6. Phosphate only (Basic Slag).
7. Potash only (Sulphate of Potash).
8. Phosphate and Nitrogen (Dried blood and Basic Slag).

These experiments were continued satisfactorily and a record of yields of the old trees, (series 1), kept until 1916, when the

hurricane of that year completely destroyed several of the plots and left others so badly battered that this series had to be abandoned.

The young trees in Series II. more or less escaped any serious damage, as at this stage of their growth they had not attained to a height of more than 2 or 3 ft.

The damage caused by the hurricane necessitated a reorganisation of the plots, and in 1917 the present system of experiments was laid out.

They are conducted in three series of 5 plots each :—

Series I. Original (Young lime trees).
,, II. Duplicate ,, ,, ,,
,, III. Triplicate (old trees found on the land).

The following treatment given to the five plots in series I. is repeated in series II. and III. :—

Plot 1. Complete manure (Dried blood, Basic Slag, Sulphate of Potash).
,, 2. Control—no manure.
,, 3. Mulch—Lemon grass and leguminous prunings at the rate of 5 tons per acre.
,, 4. Nitrogen and Phosphate (Dried blood and Basic Slag).
,, 5. Nitrogen and Potash (Dried blood and Sulphate of Potash).

The area of each plot is approximately $\frac{1}{4}$ of an acre. The trees are planted along the middle of a bed; there being 3 beds of eight trees, making a total of 24 trees to a plot. Each plot is divided from the next by a deep drain; and all such drains lead into a main drain, at the end of the plots, running at right angles.

Reliable and useful results from these experiments cannot be expected for some time to come. It would appear, however, that nothing short of a complete fertilizer can be expected to give satisfactory results; and further observations may show that mulch, such as cut grass and bush, will, when applied every second year alternating with a complete fertilizer, become an important consideration in every practical scheme of plantation manuring.

In addition to the main experiments other plots have been kept under observation since 1916, most of the trees having been planted in 1914. The most important of these consist of three plots planted with budded limes.

Plots A. and B. consist of ordinary spiny limes budded on sour orange stock, whilst plot C. is planted with the spineless* type also budded on the sour orange stock.

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* This spineless variety was discovered up in the interior by Mr. H. F. Green, of Kew, in 1890–92, when curator of these Gardens.

Compared with the ordinary spiny type its fruits are much smaller, and the bearing qualities of the tree are less prolific.

On the other hand, the rind of the fruit is much thinner than the ordinary lime, and the juice is more plentiful and much clearer, and it contains fewer seeds.

Although these three plots have undergone various treatments, the results of which are given below, the main object in planting budded trees was to ascertain whether, when budded on the sour orange, they could, by reason of the long tap root sent down by this stock, withstand the hurricanes through being more firmly anchored in the ground.

Another interesting matter was that of finding a stock immune from the *Rosellinia* root disease. Further it was hoped that the tendency to early bearing, which is characteristic of budded plants, might prove an advantage over the ordinary seedling which takes at least four or five years to come into bearing. As regards the immunity of the orange stock from attacks of *Rosellinia* disease, and the bearing qualities of the budded lime, (spiny type) no definite conclusions can be drawn at present to show whether or not these trees can be recommended for general planting.

The treatment given to these three plots commenced with the actual planting, when some of the holes were made with dynamite, and the others were made with the spade.

The results of the two methods compared showed that there was nothing to choose between one and the other. These results, being contrary to experience elsewhere with dynamite, led to the belief that the failure must have been due to the moist and compact nature of the soil, and that the use of dynamite on such lands only tends to further compaction.

Good results, it is reasonable to suppose, can only be expected on land where the shattering effect of dynamite will loosen the surrounding soil and make way for the penetration of the young roots, therefore it is not likely that the use of dynamite will meet with much success in Dominica.

The next phase of the experimental work on these plots yielded interesting and useful results : two of the three plots were planted with green dressing crops : one with Horse Beans, (*Canavalia ensiformis*), and the other with *Tephrosia candida ;* the third plot being left bare except for the weeds and grass which were kept cut at regular intervals.

The object of this experiment was to show to what degree these crops would help in the development of the young trees by affording a ground covering from the strong rays of the sun, and acting as lateral protection from prevailing winds.

Observations made on lime cultivations by the Department, extending over a good number of years, have shown that the lime tree has a critical period in its lifetime, commencing at the time of planting in the field and continuing up to the third year.

During this period unless proper attention is given, the health of the tree may become impaired to the extent of permanently weakening its constitution, and very often at this stage scale insects and other pests appear.

An annual application of 2 lbs. of organic nitrogen per tree, in addition to green dressing crops, constitutes the treatment

that should be given during this period, and is mentioned here as having some bearing on the results of the experiments under consideration; for these three plots received the complete treatment necessary to bring the plant through this stage, with the exception of plot C. which received the fertilizer only.

The following table will show the results obtained :—

	A.	B.	C.
——	Grown with Horse Beans.	Grown with Tephrosia.	Grown without Green Dressing.
	*Calculated yield in barrels per acre.	Calculated yield in barrels per acre.	Calculated yield in barrels per acre.
1917-18	34	33	24
1918-19	72	139	54

* One barrel = 4½ cubic ft. capacity.

It will be seen that the yield obtained from the plot of trees grown without green dressing compares unfavourably with those grown with Horse Beans and *Tephrosia*. Another interesting point worthy of note is the great increase in yield of B. over A. in the second year of bearing.

This may be due to the better protection afforded by *Tephrosia* which grows to a height of several feet, whereas the Horse Beans rarely attain to a height of more than 2 ft. The fact that *Tephrosia* is much slower in its growth from seed than the Horse Beans may account for the yields of A. and B. being about equal in the first year of bearing, when at that stage the *Tephrosia* would be in a more or less weakly condition, and would not give such effective protection as would the more sturdy growing Horse Beans.

When it is remembered that the ordinary seedling tree does not commence to bear until the fourth or fifth year, and even then only a few fruits are to be expected, the above results may be considered as remarkable instances of early bearing and, clearly demonstrate one of the advantages in planting budded trees.

Limes, unlike most other fruits, instead of being picked from the tree, are allowed to ripen and fall to the ground, when they are collected into baskets and conveyed to the mill.

The fruit collected from the plots in the Lime Experiment Station are deposited in heaps in front of the plots from which they have been collected, and after being carefully measured and the yields recorded are carted to the Bath Estate, the property of Messrs. Rose & Co., Ltd., to whom they are sold.

The present yield of limes from the whole of the Experiment Station is approximately 2,000 barrels per annum. As the newly planted land comes into bearing this figure should rise to between 3,000 and 4,000 barrels per annum, and later on with all the trees in full bearing between 6,000 and 7,000 barrels may be expected.

Some time in the near future it may be possible to deal with these limes in the factory which is now in course of construction in the Experiment Station. Such a factory will become an essential part of the experiments in connection with the lime industry, and may be expected to help the planter to solve a few of the difficulties that still remain to be overcome in regard to the manufacture of lime products.

Experimental work in the factory conducted in conjunction with field operations might bring to light a better means of working and improving the present lime industry, and show a more economical and profitable method of dealing with the lime from the time the tree leaves the nursery bed until its products are ready for the market.

VII.—KIKUYU GRASS.

(*Pennisetum clandestinum*, Chiov.)

O. Stapf.

In 1911 Mr. J. Burtt-Davy received from Mr. David Forbes of Athole, Amsterdam, Transvaal, a single root of a peculiar grass which he had collected on the shores of Lake Naivasha, Kikuyu, whilst hunting there, the grass having attracted his attention by the partiality which the wild game showed for it. The root was transplanted in one of the plots of the Botanical Station at Groenkloof, Pretoria, and soon established itself.* It has since flowered there regularly every year, but not seeded, the original plant and its descendants being apparently all functionally female.† In "The Farmer's Weekly" of March

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* A preliminary note announcing the introduction of the grass was published in the Report on the Department of Agriculture, Union of South Africa for 1910/1911, p. 241. Here also appears the name Kikuyu Grass for the first time.

† A short article by Mr. Burtt-Davy in the Agricultural Journal of South Africa, vol. ii., pp. 146–147, describes the experience gained with this grass in the Transvaal by them (1915), and deals with its uses and disadvantages. It also states the circumstances of its introduction, and that with some reserve it had been referred at Kew to *Pennisetum longistylum*.

23rd, 1917, Mr. H. A. Melle published a fuller account of the grass as it presented itself under cultivation, the greater part of which is reproduced here.

"Kikuyu grass (*Pennisetum longistylum*), says Mr. Melle, is a perennial, running grass, and like the 'kweek' forms a dense turf. It has branching, leafy stems. The leaves are flat and spreading. Kikuyu has numerous stout rhizomes, as thick as a lead-pencil, and by the growth of these a single plant may cover an area of several square yards. If grown in a vicinity where there is not much moisture it will make very little top-growth, but will send out shoots and spread along the ground and establish itself firmly. But in the presence of moisture it will put on top-growth. I have seen it grow 2½ to 3 ft. high. As yet it has not been observed to set seed in South Africa although it flowers regularly at the Groenkloof Botanical Station every summer.

Kikuyu is a summer grass, but will remain green until the first severe frost and will start growing again long before the veld grasses. At the time of writing our mealies have been scorched by frost and the veld grasses have become coarse and dry; whereas the Kikuyu is still putting on growth and is beautifully green and succulent. Its drought resistant qualities have proved to be equal if not better than any of the other grasses.

Kikuyu may be considered as essentially a pasture grass. In districts where the rainfall is over 30 inches it might be possible to get two or three cuttings a season. What number of plants it can carry per acre has not been ascertained, but it will probably carry more than any other grass owing to its dense and rapid growth, combined with its resistance to eradication. If a sod of this grass be taken up, a few rhizomes (underground shoots) are always left in the ground; these in two weeks' time will send out green leaves and soon re-establish themselves.

As Kikuyu can only be propagated by roots or runners the initial cost of establishing a pasture would be more than other grasses that bear seed. This, however, is compensated for by the fact that when it has been put in, provided there is sufficient moisture in the soil to start it growing, it will take care of itself. There is, moreover, no fear of it becoming choked by weeds Although Kikuyu is such a hardy and vigorous grass it would be advisable to well prepare the ground previous to planting as it will then strike immediately and have an advantage over any undesirable plant.

(*a*) Palatability.—I can say with every assurance that Kikuyu is one of the most palatable grasses. All stock eat it greedily and will leave most grasses to get to it. If stock are allowed on a patch of Kikuyu it will be seen that they will graze contentedly, and when they have had their fill they like to lie down on it, for the Kikuyu forming such a dense turf provides a very comfortable rest.

(*b*) Chemical Analysis.—From the following table kindly supplied by the Division of Chemistry, it will be seen that Kikuyu is one of our most nutritious grasses :—

Air-dried Material.	Moisture.	Protein.	Carbo-hydrates.	Fat (Ether Extract).	Crude Fibre.	Ash.	Containing true Protein.	Nitrogen.	Albumenoid Nitrogen.
Kikuyu grass -	8·29	12·36	35·06	1·7	33·08	9·42	8·31	1·977	1·330
Guinea grass - (Panicum maximum)	8·02	9·03	28·63	1·68	40·54	12·10	7·09	1·445	1·134
Warm Baths grass (Digitaria sp.)	10·94	8·33	25·22	1·72	34·56	9·23	6·13	1·333	0·980
Vinger grass -	6·93	8·12	33·94	1·68	39·68	9·65	5·51	1·299	0·882
Blauwzaad grass (Eragrostis sp.)	7·91	6·58	43·78	1·80	34·50	5·43	5·43	1·053	0·868

Kikuyu grows well on any kind of soil but thrives best on moist vlei soil. We have it growing on alluvial vlei, on heavy clay loam, on gravel clay, on red loam, and poor impoverished stiff clay. On all these it is doing remarkably well. It is also known to do remarkably well on sandy soils.

Like all other grasses Kikuyu has also its disadvantages, and amongst these the chief are :—

(1) It is a summer grass as it does not remain green throughout the winter, unless watered and not subjected to frost.

(2) As it does not appear to form seed in this country, the only means of propagating it is by runners, hence freight, which involves additional expense. And it may happen that when it reaches its destination the ground prepared for it may not have sufficient moisture to start it growing. Although this is enumerated as a disadvantage it may also be considered as an advantage; yielding no seed there is no fear of it establishing itself voluntarily in an adjoining field.

(3) Being such a hardy and persistent grower when once established, it will be very difficult to eradicate. We have a good illustration of this on the Station. About a month ago we disposed of large quantities of Kikuyu and the patch from which we took the grass three weeks ago was apparently quite clean but now is beautifully green and almost covered with Kikuyu.

(4) Kikuyu is so aggressive that no other plant can grow with it. This is a great advantage because when planted on the veld it will establish itself against any of our veld grasses of minor feeding value.

(5) There is a likelihood of a Kikuyu pasture becoming sod-bound and if this should happen, the field should be disked and ploughed or harrowed.

(6) It is only natural that a plant of such vigorous growth as Kikuyu would soon impoverish the soil.

Kikuyu responds generously to manure, for where there are animal droppings on a patch it will be noticed the grass grows there higher than anywhere else.

Lawns have been grown from this grass around the laboratories of the Botanical Division and on the terraces of the Union Buildings, Pretoria. The bright, light green colour of the foliage forms a lovely setting for ornamental gardening. It will also make an excellent field lawn as it forms a dense, soft and springy turf when closely grazed or clipped.

On account of its ability to grow on practically any type of soil and its creeping characteristics, it should be an excellent soil binder, on dam walls, on sandy soils and on eroding slopes and dongas.

Then again it can be recommended as a grass for planting in a poultry-run. Fowls seem very fond of the leaves, and owing to its aggressive nature it can withstand the ravages of the fowls' scratching, &c.

As Kikuyu is easily propagated by cuttings it may be either planted by cuttings or 'roots.' Our practice is to take the grass out in sod, then cut it up into pieces about 3 ins. square and plant it out 6 ft. by 6 ft., or 6 ft. distant between the rows and 3 ft. distant in the rows. Our results have shown that when planted 6 ft. by 6 ft. on fairly good soil it covers the ground in a single season.

Kikuyu being a summer grass the best time of planting is during the spring and summer rains, but it can be planted as late as April when the frosts do not occur before May.

In order to recover the cost of preparing the ground for Kikuyu it is possible after the last cultivation of mealies to put down Kikuyu between the rows."

Subsequently an attempt was made to introduce the grass into Mashonaland. The success seems to have been complete, as may be seen from the following note in the Rhodesia Agricultural Journal, vol. xv. (1918) p. 327 :—

"Kikuyu Grass.—As late as a year ago it was mentioned in an article in the *Rhodesia Agricultural Journal* (June, 1917) that, despite all efforts up to then, no pasture grass had been discovered suitable for Rhodesia which formed a thick bottom and might prove useful for grazing purposes. Since that date, however, our trials with Kikuyu grass (*Pennisetum longistylum*) on the prevailing red soils of Mashonaland have shown that this grass adapts itself perfectly to local conditions, and fulfils all the expectations that have been aroused from reports concerning its behaviour in the Union. The first lot of roots introduced by the Department of Agriculture were obtained from the Potchef-

stroom experiment farm in March, 1917. Through delays, these arrived in a seemingly dead condition, and after a preliminary soaking were planted out. Practically no rain fell after planting, yet by December, 1917, considerable growth had been made, and the runners became the source of our principal propagation plots. A further lot of slips were imported from Natal in December, 1917, and were planted out one foot apart each way. The resulting plot as it appeared in June, 1918, is shown in the accompanying illustration. The slips soon covered the ground entirely, and the growth was so vigorous that the paths and adjoining beds were invaded. The spreading power of this grass is one of its most remarkable features, and not only does it spread along the surface of the ground, but its runners penetrate downwards to a considerable depth in the course of a single season, making its hold upon the ground very firm, and rendering it hardy against tramping. In view of its known excellent feeding qualities, its vigour and its adaptability to Rhodesia, it can be confidently recommended. It is expected that slips in limited quantities will be available for distribution during the coming season."

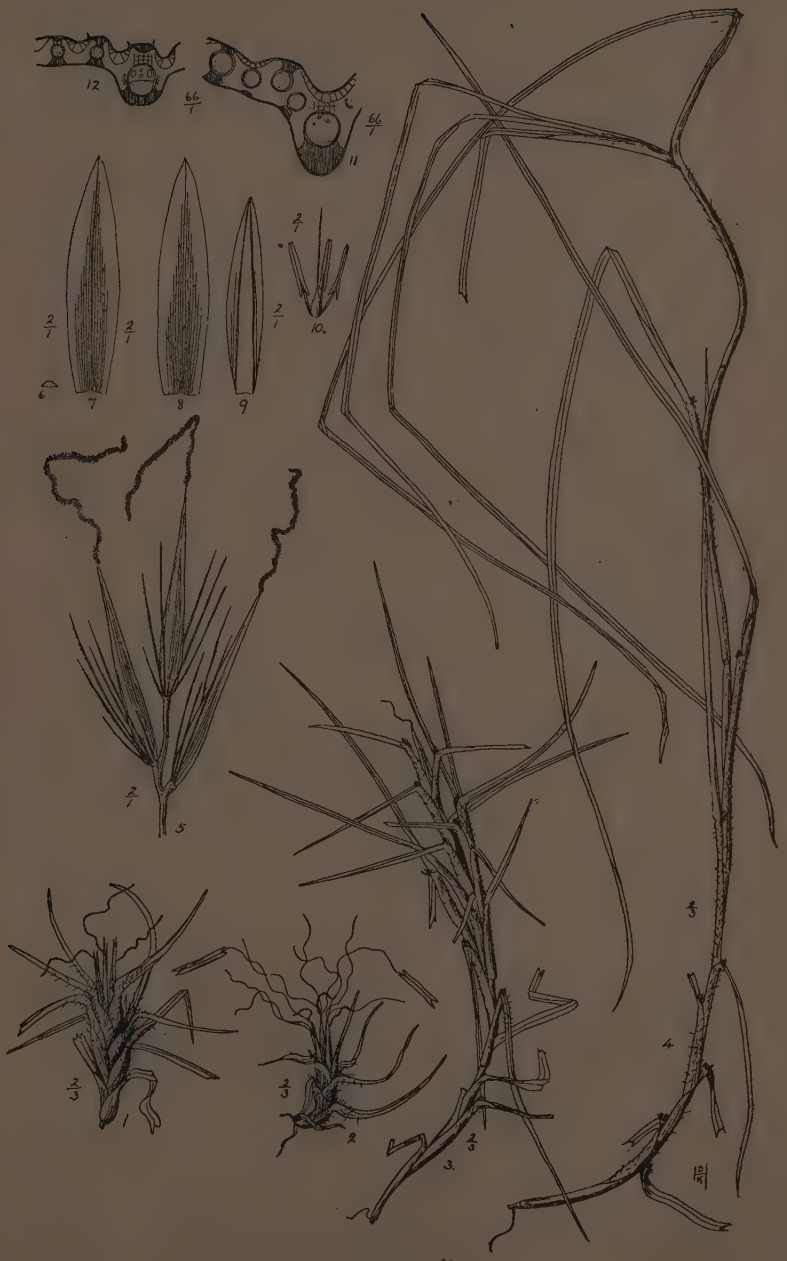
When in 1915 the first very meagre specimens of the grass reached Kew from Pretoria they were recognised as identical with some fragments of a *Pennisetum* which in 1906 had been received from Mr. A. Linton among pieces of *Cynodon Dactylon*, collected at "Linoru" (evidently meant for Lamoru, the first railway station west of Kikuyu). Both were then considered to be probably stunted and very much reduced forms of *Pennisetum longistylum*, a conception corresponding more or less to Leeke's treatment of the plant as a var. *clandestina* of the same species "congrua—— et cum forma normali evidenter consanguinea." However, after the accession of better material from East Africa, and the experience gained in the Transvaal, namely, that improved conditions did not affect the peculiar structure of the grass, it became evident that the extreme reduction of the inflorescence and the stunted condition of the vegetative parts were not casual features impressed on the plant by an especially unfavourable habitat, but fixed and perfectly definite characters of specific rank. This was also the conclusion Pilger came to when describing the grass which he had from Lamoru (collected by G. Scheffler in 1909), as a new species, *Pennisetum inclusum* (in Engler's Jahrb. xv. p. 209). Further search in the literature on *Pennisetum*, however, showed that Pilger had been forestalled by Chiovenda who had already in 1903 (Annuar. Ist. Bot. Roma, viii. p. 41) accorded the grass the status of a species, taking up an unpublished name of Hochstetter's "clandestinum" as nomen specificum. Chiovenda's species was based on a specimen of Schimper's, 2084 (no locality stated), which is not represented in the collection at Kew and the British Museum at London, nor was the species itself recorded in the Index Kewensis. Chiovenda's description, however, and his figure leave no doubt

as to the identity of the plant. Thus the Kikuyu grass will have to be known under the name proposed by him, namely, *Pennisetum clandestinum*, Hochst. ex Chiov.

The two most striking features of *Pennisetum clandestinum* (*see* Figs. 1 and 2 on p. 91) are its stunted growth and proclivity to the formation of very vigorous runners, and the extreme reduction of the inflorescence and its inclusion in the top sheath. In habit it resembles strong specimens of *Cynodon Dactylon* to a remarkable degree, so much so that barren specimens of both may be all but indistinguishable. The anatomical differences are, however, obvious, as will be seen from the cross sections shown on p. 91 (Figs. 11 and 12). Grown in good and well-watered soil it throws up barren stems up to 30 cm. (according to Melle, l.c., even 1 m.) high with elongated internodes (up to 7 cm.) and long slender blades (up to over 20 cm. by 3–4 mm.), whilst the flowering shoots seem to remain short (5–6 cm.) even under such favourable conditions (Figs. 3 and 4). The reduction of the inflorescence (Fig. 5) affects not only the number of spikelets (2–4), but also the involucral bristles which are short, the longest not surpassing three-quarters the length of the spikelet, delicate and eplumose and have evidently lost their function; further, the glumes, the lower of which is quite suppressed, whilst the upper is merely a small nerveless or almost nerveless scale; the lower floret which is reduced to its valve and finally the stamens which are occasionally arrested, the flowers becoming thereby functionally female (Figs. 6–10). The valves share the relatively great number of nerves (11–14) with those of *P. longistylum*, but they are narrower, longer, thinner and in the lower part almost devoid of chlorophyll—no doubt in response to their concealed position. The genetic derivation of *P. clandestinum* from *P. longistylum* is obvious, but the power of reversion to its ancestral type seems to have been lost. The reduction of the inflorescences to so few spikelets—and of these sometimes a portion only fertile—must mean poor seeding, a loss amply balanced by the vigour of the vegetative reproduction of the grass by runners and stolons. The area of *P. clandestinum* extends from Eritrea to Mt. Elgon and the highland of West Usambura. *P. longistylum* on the other hand is so far only known from Northern Abyssinia, and the adjoining parts of the Italian colony of Eritrea.

The following is a description of the grass :—

Pennisetum clandestinum, *Hochst.* ex *Chiov.* in Annuar. Ist. Bot. Roma, viii. 41, t. v. Fig. ii. (1903). A hermaphrodite or sometimes unisexual low creeping closely matting perennial with creeping rhizome and slender stolons with very short internodes, throwing up single or more often fascicled short stout branches, the underground portion of which is densely covered with downwards more or less decayed leaf-sheaths. Culms (over-ground stems and branches) very short, often hardly raised above the ground or growing out into long rooting runners appressed to



For explanation of figures see *p.* 93.

the ground and copiously branching to the right and left with the branches short, stout, closely sheathed and shortly ascending (*see* note on cultivated specimens below). Leaf-sheaths closely imbricate, mostly 1·2–1·6 cm. long, very rarely longer, almost membranous, very pale, then turning brown, distinctly nerved, glabrous or sparingly and shortly hirsute; ligules reduced to a densely ciliate rim; blades spreading, linear, gradually passing into the sheath, tapering to a subobtuse point, 1·25–5 cm. by 3–4 mm. (flattened out), tightly folded, then opening out, subsucculent, more or less glaucous, glabrous or sparingly and shortly hirsute, rough on the margins and the subcarinate midrib towards the tip, otherwise smooth, midrib slender, prominent below, primary lateral nerves 2–3, more or less differentiated below only. Inflorescence reduced to a cluster of 4–2 (mostly 3, rarely 1) spikelets, subsessile and enclosed for the greater part in the uppermost leaf-sheath, the terminal spikelet shortly pedicelled, the others sessile, each spikelet supported by an involucre of delicate bristles; bristles of the terminal involucre up to 15, very unequally long, the longest and strongest about ¾ the length of the spikelets, of the lateral involucres similar but much fewer and only on the outer side of the spikelet. Spikelets bisexual or functionally unisexual, slender, linear-lanceolate, 1–1·75 rarely 2 cm. long, glabrous, whitish below, greenish upwards. Lower glume suppressed, upper ovate to ovate-rotundate, subobtuse, up to 2 mm. long, hyaline, obscurely few-nerved. Lower floret reduced to its valve, this lanceolate, long tapering, subacute, as long as the spikelet, thinly membranous, 11–9-nerved. Upper floret ♂ and markedly protogynous or functionally ♀ with rudimentary stamens; valve very similar to that of the lower floret, but slightly shorter; valvule linear-lanceolate, long acuminate, very thin, 4–2-nerved. Lodicules 0. Stamens ♂ with very long, protruding filaments (up to over 25 mm. long) and dangling anthers, 5–7 mm. long, of the ♀ much reduced with linear subulate filaments slightly exceeding the ovary and empty anthers, 3 mm. long which remain permanently enclosed in the floret. Ovary obversely pear-shaped, attenuated into the long-exserted filiform style which is up to 3 cm. long, simple or shortly 2-fid and finely plumose from below the middle upwards. Grain (almost mature) dorsally compressed oblong-elliptic in outline, over 2 mm. by 1 mm. long, brown; hilum punctiform, black (Figs. 1–11, p. 91). *P. longistylum* (?) Stapf ex Burtt-Davy in Agric. Journ. South Afr. II. (1915) 147. *P. I. var. clandestina*, Leeke, Untersuch. Abstamm. u. Heimat d. Negerhirse, 23 (1907); Chiov. in Annuar. Ist. Bot. Roma, viii. 319 (1908). *P. inclusum*. Pilger in Engl. Bot. Jahrb. XLV. 209 (1910). *Cynodon Dactylon*, Schweinf. in Bull. Herb. Boiss. II. App. ii. 31 (1894), not Pers.

Distribution.—Eritrea, Ocule Cusai; by the Dégra stream near Saganeiti, *Schweinfurth* 1257 (barren)! Abyssinia; Samen;

Sabra District, Selenka, on dry spots in wet meadows, 2750 m., and at Debra Eski, in dry grassy places, 2870 m., *Schimper* 398 ! Schoa, Ankober, *Roth* 62 ! Uganda; Mount Elgon, common on open ground in the bamboo zone, 2600 m., *Dummer* 3614 ! British East Africa; near Lamoru, *Linton* 215 ! and near the same place in low bush at 3000 m., *Scheffler* 294 ! Nairobi, *Dowson* 185 ! Tanganyika Territory: West Usambara 1600 m., *Eichinger* 3294.

Melle (*see* above) has pointed out that Kikuyu grass in the presence of water will put on top-growth and attain to a height of $2\frac{1}{2}$–3 ft. A specimen from the Groenkloof Botanical Station (H. D. Agr. 19059) shows such a drawn up shoot (Fig. 4). It is about 1 ft. long, with 11 or 12 leaves, and the 6th and 7th internodes measure 5 and 6·5 cm. respectively; the corresponding sheaths are roughly of the same length, whilst their blades measure 18 and 23 cm. respectively, by about 5 mm. when unfolded. The accompanying flowering specimens stand 5 cm. above the ground, with about 7 leaves and blades 3–7 cm. long.

The flowers are as in all the allied species protogynous (Figs. 1, 2). Reduction to a functionally female condition is characteristic of all the cultivated specimens from the Transvaal as far as I have been able to examine them, and it also occurs in those collected by Roth at Ankober; but whilst the anthers of the cultivated specimens were quite devoid of pollen, those from Ankober contained beside some empty pollen grains numerous pollen-mother-cells which had not got beyond the stage of division and were loosely scattered through the anther which had dehisced.

1 and 2. Flowering branches in the female (1) and male stages (from Lamoru, Scheffler, 294). 3 and 4. A flowering (3) and a barren (4) shoot (Groenekloof, Botanical Station; cult.). 5. A whole inflorescence of a female plant (Groenekloof). 6. Upper glume. 7 and 8. Valves of lower (7) and upper (8) floret. 9. Valvule of upper floret. 10. Rudimentary stamens and ovary of a female plant. 11. Part of a cross section (including midrib) of a blade of *Pennisetum clandestinum*. 12. Same of *Cynodon Dactylon* for comparison.

VIII.—MISCELLANEOUS NOTES.

William Alexander Talbot.—This well-known and much esteemed Indian Forest Officer died on July 23rd, 1917, at the Château de Rougemont, near Château d'Oex in Switzerland. Appointed to the Indian Forest Department in 1875, he attended the Nancy Forest School and went out to India in 1876. His service there was all in the Bombay Presidency where he rose to be a Conservator of Forests in 1901. He early came into touch with Kew through his "Trees, Shrubs and Woody Climbers of the Bombay Presidency," published in 1894, and through the numerous excellent specimens which he continued to contribute to the Kew Herbarium up to the time of his retirement in 1909.

But the work by which Talbot is best known to the botanical world is his "Forest Flora of the Bombay Presidency and Sind," a large quarto work in two volumes, profusely illustrated by his sister Miss E. S. Talbot, and published in 1909 after his first book had been through two editions. Talbot's name was commemorated by Sir J. D. Hooker in the Balsam, *Impatiens Talboti*. S. T. D.

The Imperial Bureau of Mycology.—The following statement recording the establishment of the Imperial Bureau of Mycology has been received for publication by the Director from the Rt. Hon. The Secretary of State for the Colonies :—

The Imperial Bureau of Mycology is the outcome of a proposal unanimously adopted by the Imperial War Conference in 1918 that a central organisation should be established for the encouragement and co-ordination of work throughout the Empire on the diseases of plants caused by fungi, in relation to agriculture. The Committee of Management consists of some of the foremost biologists in the country, with Viscount Harcourt as their Chairman, and includes the following members :— Professor Sir Isaac Bayley Balfour, F.R.S., Mr. W. Bateson, F.R.S., Professor V. H. Blackman, F.R.S., Professor F. O. Bower, F.R.S., Mr. A. D. Cotton, F.L.S., Professor H. H. Dixon, F.R.S., Professor J. B. Farmer, F.R.S., Captain A. W. Hill, F.R.S., Professor W. H. Lang, F.R.S., Sir Daniel Morris, K.C.M.G., Mr. J. Murray, Mr. G. H. Pethybridge, Sir David Prain, C.M.G., C.I.E., F.R.S., Dr. A. B. Rendle, F.R.S., Mr. H. N. Ridley, C.M.G., F.R.S., Professor R. A. Robertson, F.R.S.E., Sir A. E. Shipley, F.R.S., Professor W. Somerville, F.R.S., and Dr. H. W. T. Wager, F.R.S.

Dr. E. J. Butler, C.I.E., late Imperial Mycologist, Director of the Research Institute, Pusa, and Agricultural Adviser to the Government of India, has been appointed Director, and has started work at the headquarters of the Bureau, No. 17, Kew Green, Kew (Telephone : Richmond 603); this site has the advantage of proximity to the fine library and collections of the Royal Botanic Gardens, with the Director and staff of which the Bureau will work in co-operation.

The funds of the Bureau are entirely provided by contributions from the various self-governing Dominions, India, Egypt, and the Soudan, and the non-self-governing Colonies and Protectorates. It will work broadly on the lines of the existing Imperial Bureau of Entomology at South Kensington, and will aim at doing for the other great class of destructive agencies in agriculture, namely, the diseases and blights of plants caused by fungi, what the older Bureau has so successfully done in regard to injurious insects. It will be a central agency for the accumulation and distribution of information and for the identification of specimens sent in from all parts of the Empire. It is proposed to issue, as soon as funds permit, a periodical journal

through which those interested in mycological work in regard to agriculture will be kept informed of progress elsewhere. There are at present over 50 officials engaged in this work in the Overseas parts of the Empire, while the number of agriculturists, planters, and the like practically interested is legion.

The effect of fungus diseases in reducing crop production is great beyond calculation. A Canadian scientist has estimated the loss caused by rust in wheat in the prairie region of Canada in 1917 at 100,000,000 bushels, representing a value of between 25,000,000*l.* and 50,000,000*l.* For the same year the loss in the five chief cereals in the United States exceeded 400,000,000 bushels. The effect of this on the provisioning of the world may be easily imagined.

The Date Palm (*Phoenix dactylifera*) **and its Cultivation in the Punjab.**—" The extraordinarily high temperature, the extremely dry atmosphere and the plentiful supply of soil water required to grow dates successfully, is a combination extremely difficult to find, and limits date cultivation to a very few places on the face of the earth." These are the concluding words of the author of the above-named work and the desired conditions he seems to have found in the Punjab. One feels that the opinion carries some weight, because it is supported by experience in the Egyptian Sudan, a land which from the beginning of time almost has been associated with the date-palm. His argument is intended to show, and rightly so, that over-production is practically impossible, notwithstanding the fact that it is also common in Southern Europe, North Africa, and the Orient; cultivated in other parts of India, Baluchistan, California, Arizona, Texas, Australia, Canary Islands and many hot, dry countries. Dried dates are imported into the United Kingdom from British India, Persia, Egypt, Gibraltar, &c., and particulars have been given in the Bulletin of the cultivation in South Australia (1895, pp. 161–162), Antigua (1896, pp. 26–28), Bussorah (1898, pp. 46–50), and Mesopotamia (1908, pp. 283–286), together with one (1914, pp. 159–162) on the sex of the seedlings—always a cause for grave anxiety as to the right proportion of male and female trees when seeds are relied on as a means of increase. Amongst authors of the comparatively few publications of recent years on the subject may be mentioned Watt (India, 1892), Fairchild (U.S. Dept. of Agric., 1903), Swingle (U.S. Dept. of Agric., 1904), Fletcher (India and countries other than India, 1906), Blatter (India and Ceylon, 1911), Popenoe (California, 1913), Brown (Egypt, 1916), and Annett (Bengal, 1913 and 1918).

The present additional work, however, is none the less timely and valuable. In desert regions, like that of the Sahara, for instance, the fruit is of first importance to the inhabitants, and

* The Date Palm and its cultivation in the Punjab by D. Milne, Economic Botanist, Lyallpur (published for the Punjab Govt., 1918), pp. 1–153 and 50 illustrations.

everywhere the persistent and increasing demand for food must be met by the further development of plants suitable to the conditions obtaining in any particular country. There are seven chapters bearing on general requirements, soil and climate, propagation, pollination, fruit preservation, diseases, &c., and a glossary. The illustrations include photographic and diagrammatic, and especially attractive amongst the latter are the diagrams relating to the root system, showing numbers and positions of secondary roots, in sections of the soil, 3 ft. wide and 7 ft. deep, at various distances of from 4–10½ ft. away from the tree, and the author concludes that "as a very large proportion of the roots only spread to a distance of a few feet from the stems explains why considerable crops of fruits can be got even when the trees are growing very close together, as they usually are in date-growing regions, and, as far as the root system is concerned, it seems to indicate that if only dates were grown a full return would not be got from the land if the trees were planted further apart than 20 ft." This knowledge of the root-system is of the utmost importance in a cultivation depending almost entirely on irrigation, and it serves a useful purpose also in the application of manures.

The same close attention to detail is obvious throughout the whole of the work, which should prove of value to anyone interested in the cultivation of this palm. J. H. H.

College Botany.*—The number of elementary botanical text-books published in English must be a high one. Each usually has both good and bad points, and the work noticed here is no exception to this general rule. The author is professor of Plant Pathology and Cecidology at Rutgers College, N.J., and has already published a text-book of "Applied Botany." The subject, in the work now under notice, is dealt with in such a manner as to present as many different phases of botany as possible, and to give the student a very general and very broad view. This method of teaching, which has found particular favour in America, has many advantages as well as some obvious disadvantages. Naturally, when nearly every branch of the science is introduced, it is only possible to give outline details which sometimes tend to degenerate into dogmatic statements. Dr. Cook's book aims to make a combination of the elementary principles of pure and applied science, but the result seems an unequal mixture rather than a combination. The most satisfactory feature of the book is the reproduction of many excellent photographs. The subjects for these are uniformly well selected. The outline text-figures are some clear, many indifferent and several seriously inaccurate. W. B. T.

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* College Botany, Structure, Physiology and Economics of Plants by M. T. Cook, J. B. Lippincott Co., 1920, 12/6 net.

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